TRANSFORMATIVE EDUCATION FOR LONG-TERM BEHAVIOR CHANGE: PREVENTING CHILDHOOD OBESITY AND IMPROVING HEALTH THROUGH IN-SCHOOL CURRICULUM-BASED NUTRITION AND EXERCISE PROGRAMS

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Transformative Education for Long-Term Behavior Change:
Preventing Childhood Obesity and Improving Health through
In-School Curriculum-based Nutrition and Exercise Programs

by

Scott Christopher Turner

ABSTRACT

BACKGROUND: Nearly half of obesity cases begin in childhood, with 80% persisting into adulthood. This highlights a compelling need to improve child obesity (CO) prevention programs. In-school programs, which are multicomponent, structured, rigorous, long-lasting, and include parents are particularly effective. Nevertheless, longer term impact is poorly understood.

METHODS: This study used a curriculum design theory lens to evaluate the long-term impact among middle school students of elementary school childhood obesity prevention programs, by focusing on Operation Tone-Up® (OTU). OTU has been implemented for over 10 years in lower income elementary schools in many states, and has positive, material, short-term outcomes. A mixed methods, retrospective, *quasi*-randomized, longitudinal study was conducted, controlling for sex, socioeconomic status (SES), ethnicity, grade level, and other factors. Three hundred seventy (370) predominantly Hispanic, lower income students in grades 6-8 in Maricopa County, Arizona were surveyed in May 2012 about their past participation in OTU and their current nutrition and physical activity (PA) knowledge, attitudes, and behaviors.

RESULTS: The intervention had significant effects on health outcomes, although these effects declined during the years after participation. Students in grades 6-8, who had participated in OTU in elementary school, had significantly healthier nutrition knowledge than control students ($\beta = 0.831$, $p = .013$, odds ratio = 2.295), and had healthier nutrition attitudes and nutrition behavior. Intervention students were significantly more likely to report high PA behavior ($\beta = 0.798$, $p = .028$, odds ratio = 2.221). In addition, girls in the intervention group reported significant, much healthier PA than girls in the control group. Intervention participation helped to increase the healthy behavior of lower income, female, and Hispanic populations.

CONCLUSIONS: The study showed that effective anti-obesity interventions can have significant positive short-term impacts on children, but their effects decline over the long-term. Ideally, maintenance should occur over many years by continuous "spiral learning" reinforcement and increasing school time spent on effective health and physical education (HE; PE). At the same time, HE and PE should be made more effective at improving behavior outcomes. HE and PE should also be integrated into the core preK-12 school curriculum, standards, and tests in order to maximize long-term follow-through and impact. The CO prevention movement should also use curriculum theory and HE and PE associations with increased academic performance to help bridge the gap between health educators and school leaders.

KEYWORDS: childhood obesity, school, nutrition, exercise, physical activity, fitness, health education, healthy behavior, habits, prevention, long-term, curriculum, curriculum design theory, academic performance

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ABBREVIATIONS

The following are abbreviations used throughout this study:

ACA	Affordable Care Act ("Obamacare")
ATC	Accept the Challenge (non-profit, 501(c) 3 organization that develops and implements the CO prevention program, Operation Tone-Up®)
BMI	Body mass index (weight & height proportion used to measure overweight & obesity levels)
BP	Blood pressure
CDC	Centers for Disease Control and Prevention
CO	Childhood obesity
DV	Dependent variable
HE	Health education
IC	Informed consent
IV	Independent variable
IRB	Institutional Review Board (entity and process for reviewing and approving academic research)
MVPA	Moderate-to-vigorous physical activity
NGO	Non-governmental organization (a "nonprofit")
NIH	National Institutes of Health
NSLP	National Student Lunch Program (free government-subsidized lunch at school)
PA	Physical activity
PAAC	Physical activity across the curriculum (PA in many courses and class times)
PE	Physical education
PH	Public health
RA	Research assistant

RCT	Randomized controlled trial
SD	School district
SE	Socioeconomic
SES	Socioeconomic status (low SES=low income/socioeconomic status)
TTM	Transtheoretical model
USDA	U.S. Department of Agriculture
USDHHS	U.S. Department of Health and Human Services

DEFINITIONS

The following are definitions used throughout this study:

Childhood obesity	While the CDC measures CO based on BMI at or above the 95th percentile for children of the same age and sex (Centers for Disease Control and Prevention, CDC, 2013b), CO here refers more generally to the phenomenon and associated problems related to overweight and obesity among children, including health, education, and other issues.
Common core	Academic standards agreed by the vast majority of state authorities as the basis for their school curriculum; becoming *de facto* national curriculum standards.
Core curriculum	Reading/writing/English, math, and the social and natural sciences typically taught in elementary and middle schools as part of the standard school district curriculum; now often perceived as excluding or minimizing health education, the arts, and/or physical education (PE). Increasingly defined by common core curricular standards accepted by a growing percentage of states.
Curriculum-based	Educational programs, which include structured materials and experiences with a particular scope and sequence in elementary and middle schools, typically delivered wholly or in part in a classroom setting.
Curriculum design	Developing and structuring learning in an optimal manner.
Curriculum theory	Theory of how to plan, develop, implement and evaluate learning effectively.
Ethnically diverse	Hispanic, African American, Native American, and other non-White/ non-European American-origin populations.
Exercise	Structured moderate-to-vigorous physical activity (as opposed to, for example, typical recess or more sedentary, non-aerobic aspects of traditional PE).
In-school	School-based programs offered on-campus during normal school hours, sometimes during a PE class, often in a classroom supervised by the normal classroom teacher, and typically mandatory (rather than optional, after-school, off-campus, during summer school, at a club, in medical offices, and so forth).
Intervention	Childhood obesity program implementation, typically intended to reduce obesity and increase healthy behavior (often in conjunction with a non-school third-party such as a nonprofit, and distinct from the

	core curriculum and other standard school district nutrition, PE, and other curriculum).
Long-term	Over many years (at least one or more years after intervention, typically 2-3 years or more).
Metabolic syndrome/ dysfunction	A combination of cardiovascular and other health risk factors, such as hypertension, high cholesterol, high blood sugar, and excess abdominal fat that can occur in obese and unfit children and adults.
Moderate PA	Physical activity that increases breathing and heart rate higher than normal.
Physical activity	Bodily movement produced by skeletal muscles that requires energy expenditure (WHO, 2013); abbreviated PA.
Physical education	Instruction in the development and care of the human body, including physical activities and exercise; abbreviated PE.
Prevention	Keeping children from becoming obese (and often including the connotation of improving nutrition and PA habits generally, in order to improve healthiness of behavior and health outcomes).
Program	Curriculum and/or other activities and materials making up a learning plan, such as an intervention; sometimes refers to an intervention as a whole.
Reduction	Decreasing children's obesity or overweight level, often as measured by BMI.
Rigorous PA	Physical activity, often through aerobic exercise, which elevates the heart rate and stresses key muscle groups significantly enough and over a long enough period to materially improve resting heart rate and blood pressure and build materially greater muscular strength.
School-based	Offered at the school, typically on-campus during the normal school year, whether in-school during normal school hours, or before- or after-school (rather than during the summer when regular school is out of session, at a club, in medical offices, and so forth).
Socioeconomic status	Economic and social position relative to others; abbreviated SES. Based on household income level and therefore qualification for subsidized free lunch at school in this study, but may also include education and occupation in other studies.
Vigorous PA	PA that increases breathing and heart rate much higher than normal (CDC, 2012b), typically resulting in hard breathing and sweating.

CHAPTER ONE: THE STUDY

Introduction

Obesity has become the most costly public health issue facing the United States (Behan & Cox, 2010; CDC, 2009; Finkelstein, Trogdon, Cohen, & Dietz, 2009; Shaping America's Youth, 2010; USDHHS, 2010), with major social as well as economic costs. Preventing childhood obesity (CO) is an important part of any ultimate solution, particularly since much of adult obesity begins in childhood. In-school CO prevention programs (Jansen et al., 2011; Katz, 2009; Stewart-Brown, 2006; van Sluijs, Kriemler, & McMinn, 2011), which are multicomponent (Kriemler et al., 2011; Laitsch, 2009), structured and rigorous (Laitsch, 2009; Metcalf et al., 2012; Jansen et al., 2011; K. D. Reynolds & Spruijt-Metz, 2006), are of substantial duration (Fjeldsoe, Neuhaus, Winkler, & Eakin, 2011; Keirle & Thomas, 2000; Stewart-Brown, 2006; Veugelers & Fitzgerald, 2005), and which include parents (Ballard & Alessi, 2006; Kitzman-Ulrich et al., 2010; Leviton, 2008; van Sluijs et al., 2011), have proven particularly effective short-term. Nevertheless, the long-term impact of such interventions is poorly understood (Hilbert et al., 2008; Laitsch, 2009).

In-school CO interventions have typically been based on health psychology theoretical frameworks, rather than curriculum theory, which may limit their acceptance by schools. Curriculum theory addresses how to plan, develop, implement, and evaluate learning effectively. Curriculum design theory describes, in particular, how to develop and structure learning in an optimal manner. This study uses a curriculum design theory lens to evaluate the long-term impact among middle school students of elementary school CO

prevention programs, which also typically aim to improve children's overall nutrition and/or physical fitness.

The study focused on Operation Tone-Up® (OTU), a nutrition and exercise intervention with material short-term outcomes, which has been operating for over 10 years in Arizona and other states. Given OTU's multi-year track record, a longitudinal retrospective study was conducted, comparing students now in middle school who participated in OTU in elementary school, with their current peers in those same middle schools who did not participate in OTU in elementary school. These never-participated students are the control, comparison group. Differences in students' health behaviors up to 3 years after elementary school and 4 years after intervention participation were evaluated, based on including former participants currently in "downstream" middle schools in the surveys.

The obesity problem in the U.S. is now considered by the U.S. Surgeon General to be the nation's most widespread and rapidly growing health crisis (Shaping America's Youth, 2010; USDHHS, 2010). Obesity is implicated in diabetes, high blood pressure, heart disease, certain cancers, and many other health issues, generating over 10% of all health care costs in the country (Finkelstein et al., 2009). A recent meta-study by the Society of Actuaries (Behan & Cox, 2010) indicates that the annual cost of obesity in the United States now exceeds $270 billion, with direct medical costs from conditions resulting from obesity rivaling costs for cancer and smoking, according to the Centers for Disease Control and Prevention (2009). For example, diabetes is closely associated with overweight and obesity, as well as with poor nutrition and lack of physical activity. Direct and indirect costs from diabetes alone are estimated to exceed $250 billion annually, including from absenteeism,

loss of productivity and productive economic capacity, disability and other impacts (American Diabetes Association, 2013). The *Journal of the AMA* reported in 2010 (Flegal, Carroll, Ogden, & Curtin, 2010) that two-thirds of adults and one-third of children in the U.S. are overweight, and about half of overweight Americans are obese (Flegal et al., 2010). Even at a young age, low socioeconomic (SE) level children with high BMI (body mass index) tend to already have worse cardiovascular health (Singh & Evans, 2010), and by adolescence a number have arterial blockage similar to typical adults in their mid-40s (Raghuveer et al., 2008).

What is more, among children and adolescents, obesity often leads to lower school attendance and academic achievement (Daniels, 2008; Geier, Foster, Womble et al., 2007; personnel and students of El Monte School District, personal communications, 2010-2011), as well as low self-esteem, anxiety, lack of confidence, withdrawal, and depression (Barlow & Dietz, 1998; Dragan & Akhtar-Danesh, 2007; Geier et al., 2007; personnel and students of El Monte School District, personal communications, 2010-2011).

By the time children reach age 13, it is often too late to change their weight trajectory. Approximately 80% of children who enter adolescence overweight become overweight adults, and overweight children have a six times greater chance of being overweight as adults than normal-weight youth (Herman, Craig, Gauvin, & Katzmarzyk, 2009; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). Indeed, Lieberman, Robbins, and Terras (2009) found that adolescents' weight-related habits can be very difficult to change. They often need to have gone through a transformative experience that changed their self-image related to weight and physical activity, to have engaged in intense daily physical activity, and/or had a health-oriented family member, in order to have turned a corner on obesity—all likely to be rare

occurrences, especially in low SE and already obese families. This vicious cycle continues throughout life, with a particular impact on vulnerable populations. One study finds that 80% of the children of obese parents become obese themselves (Whitaker et al., 1997).

Almost half of adults in the U.S. have chronic health conditions (CDC, 2013a), and many of these conditions begin in childhood and are linked to obesity (Dietz, 1998; Weiss, Bremer, & Lustig, 2013). In addition, obesity is much more prevalent in Hispanic and African-American children than in non-Hispanic White children (Whitaker et al., 1997). Girls face particular risks, too, as physical activity declines in adolescence relative to boys (Sallis et al., 2003; Thomas, Williams, Rowe, Davies, & Baker, 2010; Williams & Mummery, 2011). What is more, there are apparent lifelong advantages to normal weight and healthiness in childhood. For example, Morrison, Glueck, Horn, and Wang (2010) found in a 22-year longitudinal study that medical office blood measurements at ages 6-18 years old predicted Type 2 diabetes onset later in life. "When BMI, SBP (Systolic Blood Pressure), and DBP (Diastolic Blood Pressure) were all lower than the 75th percentile and there was no parental DM (Diabetes Mellitus), the likelihood of children developing T2DM (Type 2 Diabetes Mellitus) 22 to 30 years later was only 1%" (p. 58).

The obesity epidemic is not unique to the U.S. Obesity is now a worldwide health epidemic along with other, in many cases preventable chronic health conditions such as heart disease, high blood pressure, and diabetes. According to the OECD (Sassi & Devaux, 2012), "at least one in two people is now overweight or obese in over half of OECD countries" (p.5). Many of these conditions begin with unhealthy behaviors in childhood, including half or more of overweight and obesity in the U.S., Canada, the UK and Mexico (Sassi & Devaux, 2012). Recently, the obesity rate in Mexico exceeded the US, and many developing

countries are heading in this direction (Croppenstedt et al., 2013). Given that the United States is further down the learning curve than most other countries in fighting the obesity epidemic, it is of global importance to understand what the USA has found to be effective in preventing obesity and developing healthier, ideally lifelong behaviors,

Many upper- and middle-class Americans do not appreciate just how pervasive the obesity problem is, because so much of the epidemic is occurring out of their sight, in lower income non-White communities, where obesity rates tend to be much higher than the national average (Wang & Beydoun, 2007). For example, low-income teens in California are three times more likely to be obese than higher income children of the same age (Summit On Health Nutrition and Obesity: Actions for Healthy Living, 2010). This may help explain why the country has responded so slowly to the obesity crisis. Indeed, it appears that only a small percentage of senior policymakers and opinion leaders have been directly affected by obesity. For example, Governor Christie of New Jersey is one of the few national-level politicians who is seriously overweight, and one is hard-pressed to think of others. In fact, Governor Huckabee lost over 110 pounds before beginning his 2007-08 national campaign for U.S. President (Barrett, 2005), and Governor Christie, who is considering running for president, underwent lap-band surgery in February 2013 (Neporent, 2013). It seems to have taken a national figure, who is socioculturally attuned to the obesity plight of lower income communities, Michelle Obama, to have brought a broader national focus on the epidemic (Isaacs & Swartz, 2010).

In contrast, infectious diseases common in early- to mid-20th century America, such as measles, mumps, and chicken pox, which were arguably much less dangerous and life-threatening than obesity, appear to have received much more political attention. How could

this be? This dichotomy may to a substantial extent have arisen, because virtually everyone in the U.S. was impacted by these infectious diseases, regardless of socioeconomic class or political power. In this sense, the political system's reaction to obesity can be likened to the national response to AIDS. AIDS had a very low profile in the U.S. for many years, when it was mainly prevalent among homosexuals and drug users (Shilts, 1987). Some argue that only the combination of activism ("The end of AIDS? Thirty years of a disease," 2011) and the realization that non-drug-abusing heterosexuals could get AIDS, finally lifted AIDS's profile adequately to ensure a determined, high investment governmental response (Wikipedia, 2013).

Thus, childhood obesity is a social justice issue. It affects many of the most vulnerable in society, plaguing ethnically diverse and lower socioeconomic-level groups. Yet given its devastating negative impact, political leaders are not engaged enough in the obesity epidemic, and have kept it a low, poorly funded, minimally legislated policy priority. Even now, after a more than 20 year public health community acknowledgement that obesity is a dangerous epidemic, public policies to-date can still be characterized as minimal relative to obesity's impact and cost to society (Harvard School of Public Health News, 2012; NIH, 2013).

The current morass is prolonged by entrenched ideologies and political and economic interests. CO's persistence highlights the influence of food and beverage corporate interests in impeding legislative and regulatory changes, which could hurt corporations, yet help the public (Kessler, 2009). Politically, on the one hand, many "progressives" say that they care about the lower-income, ethnically diverse families most affected by issues such as low-quality public schooling and obesity, but some actually appear to care more about teachers'

unions than children and their families; fortunately, this is starting to change, but too slowly (Democrats for Education Reform, 2013).

On the other hand, many "conservatives" naively claim, against the objective evidence, that improving academic subject teaching alone will achieve enough socioeconomic benefit for our society, and that schools do not need to address other areas such as health education. According to many of them, no additional resources need to be or should be allocated to provide lower income, ethnically diverse families with more equal opportunity for better education and health. We allegedly just need to set high expectations and hold teachers accountable in order to improve education adequately (Linn, 2003). It appears that the intense focus by many on minimizing taxes rationalizes an egregious disregard of the evidence that lower-income schools need many more resources, in order for their students to come close to having similar opportunities in life to middle-to-upper-class children (Baker, Sciarra, & Farrie, 2010).

A more recent ideology, which exalts "wholesome," "real" food, sometimes regardless of fat content, and disparages virtually all "processed" food, has been criticized in *The Atlantic* (Freedman, 2013). Freedman notes that many "celebrity chefs" and popular nutrition pundits disregard the cost and practicality of their nutritional advice for lower-income families.

Nevertheless, there is a growing awareness of the high cost to society as a whole of obesity and other chronic health conditions, especially through Medicaid, Medicare, Affordable Care Act (ACA; "Obamacare"), and private health insurance costs shared by all taxpayers and policyholders. By addressing both the social and economic cost of obesity and chronic health conditions, there is potential to gain "tripartisan" support for change: from

Republicans, Democrats, and independents. Re-allocation of individual, employer, and government spending from disease management-focused health care to more productive areas of the economy could generate a substantial net increase in income and jobs, and make the U.S. economy and its citizens much more competitive in the global economy (Butler & Haislmaier, 1989; White House Council of Economic Advisers, 2009).

Global, Economic, and Political Perspectives

At present, total public plus private health care expenditures make up close to 18% of U.S. GDP, dramatically higher than the next highest OECD countries including Canada, France, Germany, and the Netherlands (OECD, 2012), which are in the 11-12% of GDP range. This 6-7% GDP gap is equal to about $1 trillion annually in apparent excessive health care spending in the U.S. Furthermore, OECD developed country average health care expenditures are even lower, 9.5% of GDP, close to half of the U.S. Yet many broad U.S. health outcomes are worse than the OECD average, including one year lower life expectancy. Helping to close this gap by proactively preventing and reducing chronic diseases, instead of the current focus on managing diseases reactively, post-diagnosis, would not only make Americans much healthier, but could ultimately free more than $1 trillion of the economy for other purposes.

National-level costs are daunting, but the statistics are even more insightful when presented on an individual, per-person and family household basis. Viewed on a per-capita basis, the U.S. spends US$8,233 per person for health care on a purchasing power parity (PPP) basis, which is 35-36% higher than the second and third next most expensive countries: Norway at $5,388 and Switzerland at $5,270 per person. Closing this gap could free up nearly $3,000 in average income per person in the US. Even just lowering the growth

rate in health care costs could have a huge impact on the economy and families. According to the White House Council of Economic Advisers (2009):

> Slowing the annual growth rate of health care costs by 1.5 percentage points would increase real gross domestic product (GDP), relative to the no-reform baseline, by over 2 percent in 2020 and nearly 8 percent in 2030. For a typical family of four, this implies that income in 2020 would be approximately $2,600 higher than it would have been without reform (in 2009 dollars), and that in 2030 it would be almost $10,000 higher. Under more conservative estimates of the reduction in the growth rate of health care costs, the income gains are smaller, but still substantial. (p. 2)

Due to this economic upside potential, these healthy behavior economic benefits from improving health preventively therefore have the potential to build a broad political coalition to support the necessary policy changes and public investments. On the other hand, continuing to work almost exclusively on improving the current disease management-oriented system, which has been the main reform focus, has had very limited long-term impact to-date, as health care continues to take up an increasing share of economic activity. An aging population and obesity-related health costs are expected to worsen this situation, and push health care to 20% of the U.S. economy in the coming years (Kaiser Health News, 2013).

At the state level, this unhealthy dynamic often takes the form of public funds being transferred from education to Medicaid, as Medicaid costs rise much faster than state budgets (National Conference of State Legislatures [NCSL], 2013). At the federal level, this cross-sector wealth transfer is taking place in the form of, among other changes, reduced federal subsidies for student college loan interest rates, while Medicare and Medicaid costs rise faster than general inflation, and public debt payable by future generations grows dramatically.

Obesity and Schools

Many experts believe that prevention through the education of children may well be the most viable, cost-effective answer to preventing obesity on a large scale. "The American Obesity Association (2002) has noted that families and schools influence children most concerning their nutrition and involvement in physical activities" (Ballard & Alessi, 2006, p. 20). Many scholar-practitioners, including those who have systematically reviewed childhood obesity interventions over many years of implementation, have found school-based programs to be particularly effective (Bachman, Singhal, Mishra, & Foster, 2010; James, Thomas, Cavan, & Kerr, 2004; Jansen et al., 2011; Jepson, Harris, Platt, & Tannahill, 2010; Katz, 2009; Kriemler et al., 2011; Leviton, 2008; Veugelers & Fitzgerald, 2005). Reinforcing the importance and potential of preventing obesity before it happens, Leviton (2008) and others have noted that prevention of CO is the appropriate goal of school intervention, and that prevention requires "small but consistent" changes, not radical and expensive ones—though this is admittedly easier said than done.

Yet there is little research on the longer term impact of in-school programs in preventing childhood obesity and improving children's health. There has also been a notable failure by health educators to address how to gain broad acceptance of CO prevention programs into schools. As discussed later, this can be traced in part to health professionals' failure to use a curriculum theory framework and to present their case persuasively to school decision-makers.

It is hard to permanently change adults' fundamental behaviors, including in areas such as nutrition and physical activity. It is preferable from a human development perspective for people to learn many key behaviors as children (Goldhaber, 2000;

McDonough & Engel, 2011; Schunk, 2012). Unfortunately, even becoming a parent may not motivate a mother or father enough to improve their habits; indeed, it may even worsen parents' nutrition and physical activity (Hamilton & White, 2010; Laroche, Heisler, Forman, Anderson, & Davis, 2008; Laroche, Wallace, Snetselaar, Hillis, & Steffen, 2012). A review of the school and public health education literature, and a back-of-the-envelope calculation of the costs and difficulty of (re-)educating the fundamental nutritional and physical activity habits of the majority of adult Americans, imply that it is much less expensive and more feasible to educate society as a whole through the school system, rather than later in life (Benson, Storey, Huntington, Eberle, & Ferris, 2008; H. S. Brown et al., 2012; CDC, 2009; Raphael, Anderson, & McCall, 1999; Smith, 2006).

Yet the most powerful potential forum for preventing childhood obesity and improving children's health behaviors, the nation's school systems, are barely involved. In many school districts, particularly the poorest ones with the highest childhood obesity rates, health education in schools, including PE, has in many cases been declining, in spite of the growth in obesity (Mayer, Smith, & McDermott, 2011). This is due in large part to the growing prioritization of improving standardized test scores in "core," tested subject areas (Berliner, 2011), while government spending on public education has been under substantial pressure (NCSL, 2013).

Ironically, the growth in health care spending on Medicaid, which is driven to a great extent by chronic health conditions such as obesity among low SE populations, is arguably the primary long-term cause of lower education spending, as state legislatures make hard choices between paying for health care for lower income populations vs. investing in education. Given their fixed resource pie of school time and personnel, school districts have

responded to academic performance and financial pressures by cutting perceived non-core areas—including in many cases health education and PE. American society has, de facto, if only subconsciously, opted to improve academic education at the expense of the nation's health, creating a vicious downward spiral in health and fitness education and other education investments, as chronic health conditions grow.

We can therefore only give government and civil society very mixed grades in how they are responding to this crisis. First, it is taking far too long to develop broadly accepted, highly effective, low-cost CO prevention solutions which can realistically be implemented in schools and elsewhere. Evidence of the obesity epidemic has been building for 20-30 years, yet no consensus school-based or other solutions have emerged. Second, even if such solutions and consensus existed, health education advocates have not figured out how to get school districts to implement effective CO prevention programs, in the current environment of an overwhelming focus on core academic performance.

In these circumstances, what can be done about childhood obesity through school systems? Obesity is a rampant, life-threatening health epidemic among one-third of society, with another one-third suffering the consequences of overweight, and these conditions show no sign of receding substantially. What will it take for the United States to get serious enough about the obesity epidemic, so that key governmental policies and mechanisms including preK-12 education are dramatically improved to address it?

Problem Statement and Purpose

In spite of the increasing number of interventions in schools to improve students' nutrition and exercise, and other measures being taken outside of schools to combat childhood obesity, obesity and poor health among children persist at extremely high levels

(Flegal et al., 2010). The purpose of the present study is to understand the long-term impact of in-school curriculum-based nutrition and exercise programs intended to prevent childhood obesity on students' health-related knowledge, attitudes, and behaviors. By using a curriculum theory perspective, this study takes a different approach than health psychology-oriented perspectives in the past. This may help enhance understanding of the impact of these preventive health programs and their role in and acceptance by schools.

Background and Context

The obesity epidemic is a very complex phenomenon. Poverty, family dynamics, ethnic and other sociocultural issues; educational systems; physiology and genetics; food distribution and marketing; policies at multiple governmental levels on food, beverages, nutrition, education, physical fitness, public health, and recreation; public health and general healthcare information and delivery; government funding; community relations; and many other factors impact obesity (Evenson, Ballard, Lee, & Ammerman, 2009; Gittner, 2009; Ross et al., 2010). Stated somewhat differently, Raine's (2005) conceptual synthesis of the literature revealed that

> individual determinants of personal food choice (physiological state, food preferences, nutritional knowledge, perceptions of healthy eating and psychological factors) are necessary, but not sufficient, to explain eating behavior, which is highly contextual. Collective determinants of eating behavior include a wide range of contextual factors, such as the interpersonal environment created by family and peers, the physical environment, which determines food availability and accessibility, the economic environment, in which food is a commodity to be marketed for profit, and the social environment, in which social status (income, education and gender) and cultural milieu are determinants of healthy eating that may be working "invisibly" to structure food choice. (pp. 8-9)

As part of this broader discussion, this study is anchored in the interdisciplinary human development and human and organizational systems literature related to habit

formation through learning. The fields of study on habit formation and learning are closely tied to theories of behavior, cognition, and social ecology; education and health psychology; child and family development; motivation, education, and learning theory including curriculum and instructional design theory; and public health (PH) and health education theory. (Others add genetics, law, economics, and social ethics to this list; Hilbert, 2008.)

In addition, since the study focus is on habit formation through schools to help address the childhood obesity epidemic in the context of the overall U.S. educational system, American society, the U.S. political system, and the U.S. and global economy, human development perspectives must be supplemented by organizational and systems perspectives. So the fields of organizational theory, as well as systems theory including sociology, social change and critical social and pedagogy theory, world-system theory, complexity theory, social entrepreneurship theory, and other areas are relevant. While the study epistemology is principally post-positivist, with a focus on quantitative analysis using traditional statistical approaches, the study also includes hermeneutic and critical social perspectives as part of its mixed models approach (Bentz & Shapiro, 1998).

In brief, this study research directly and indirectly engages a broad range of epistemologies, disciplines, and scholarly discussions. Many researchers have discussed the complex interplay of factors, which are causing the obesity epidemic, and the related need for a multi-faceted, multidisciplinary range of solutions to impact it (Hilbert et al., 2008; Nemet et al., 2005; K. D. Reynolds & Spruijt-Metz, 2006). Hilbert et al. (2008) describe how difficult this can be:

> Multidisciplinary work is a challenge in itself: It requires establishment of a common method and language that can be used by all cooperating disciplines in order to provide a systematic basis of joint preventive action. Overall, the current analysis shows that an interdisciplinary perspective furthers understanding of the complexity

> of this condition and can inform public health strategies on obesity. Future multidisciplinary work will need to (Nemet et al., 2005) build upon knowledge from further disciplines concerned with obesity risk or prevention or both, such as public health, nutrition, or political sciences, in order to generate structured, comprehensive and fair solutions to this complex childhood condition. (p. 23)

Ultimately, given obesity's complexity, including its origins, interactions, and effects at virtually all "levels" of the individual—genetic, physiological, rational, emotional, social, cultural, economic, and so on—and at virtually all levels of the social ecosystem—from the family and school to the highest levels of government and corporate life—it seems likely that multiple would-be obesity prevention solutions will be needed to act at all of these levels, at least to some extent. Siega-Riz et al.'s (2011) observation could have been made by any number of intervention implementers: "Although our intervention had multiple components that were well integrated, this particular combination of intervention strategies may have not been sufficient to penetrate into the other levels of the social-ecological model for levels of influence which can improve overall dietary behaviors." (p. 7) This cautionary note implies that scholar-practitioners must be mindful of the broader social and political context, as they pursue practical and effective CO solutions.

Indeed, Leviton's (2008) review, supported by Green and Kreuter (2010), describes the many mutually interacting influences on individual health and behavior throughout society, and therefore the importance of addressing social issues at several levels simultaneously. Story et al. (Story, Sallis, & Orleans, 2009) concur: Environmental approaches "can affect large populations, can reach traditionally underserved populations, are likely to have long-term or permanent effects, and can…support education and behavior change interventions" (p. S1). Nevertheless, as those involved in the Kaiser Permanente Health Initiative have noted, the reality of programs and policies implemented to date

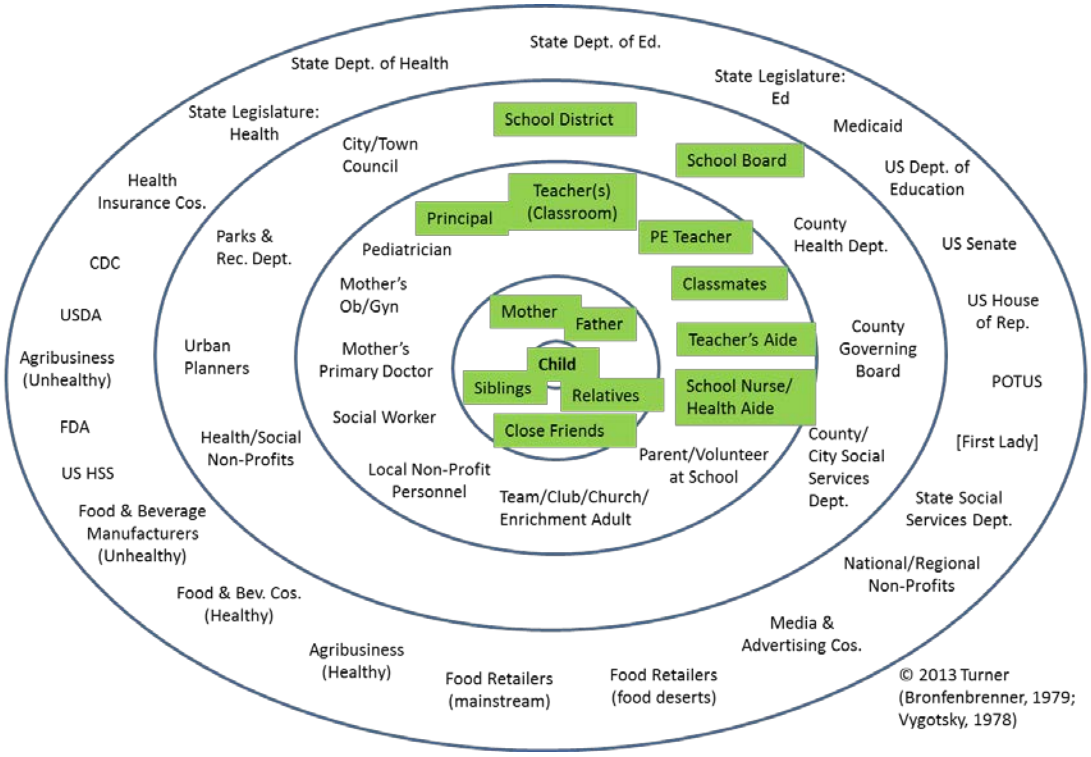

Figure 1. Influencers of children's CO and health-related behavior.

is that interventions are still too small in relation to the size of the challenge (Cheadle et al., 2010). Interventions need to be occurring much more pervasively, and ideally policy "interventions" as well as family (Crespo et al., 2012; Epstein, McCurley, Wing, & Valoski, 1990; Laroche et al., 2008) and school-level interventions are needed.

Significance of Study

Childhood obesity prevention programs that have long-term effectiveness could provide significant health-related and psycho-social benefits to participants. Likewise, there could be significant benefits to those impacted indirectly by obesity, including family members, schools, and society more broadly, including health insurance policyholders and taxpayers, who pay for many obesity-related costs. Although highly effective CO prevention

and health education practices exist, there is no consensus on which particular in-school programs are best for preventing childhood obesity. As a result, any additional insights on program effectiveness could be valuable. In addition, by using a curriculum theory perspective, the potential for greater long-term impact and generalizability of the study could be further increased. Relatedly, since curriculum and instruction personnel and perspectives are key decision-making gatekeepers for in-school programs, curriculum theory perspectives may be particularly influential in gaining school decision-makers' acceptance and helping to expand the school penetration of curriculum-based exercise and nutrition programs that can help prevent and reduce childhood obesity.

Conceptual/Theoretical Framework

The principal theoretical framework used in this study for analyzing the existing literature was curriculum theory, particularly curriculum design theory. Curriculum theory addresses how to plan, develop, implement, and evaluate learning effectively. Curriculum design theory addresses, in particular, how to develop and structure learning in an optimal manner.

Curriculum theory has several distinct advantages compared to health-oriented theories commonly used with anti-obesity interventions in schools. Curriculum theory incorporates behavioral, cognitive, and even social-ecological perspectives (Ornstein & Hunkins, 2009; Schunk, 2012), which have been the predominant conceptual frameworks for obesity-related school health interventions. What is more, curriculum theory is educationally oriented, with a focus on optimizing classroom learning from educators' points of view, by using evidence-based educational psychology and practice. By using approaches based on educational psychology, rather than general or health-oriented psychology, and speaking in

educators' own community of practice "language," curriculum theory-based interventions are better positioned to be heard and understood by educators in general, and curriculum and instruction personnel, in particular (Lave & Wenger, 1991; Wenger, 2009). This is crucial for gaining increased attention and acceptance in school districts of health education programs, in general, and obesity prevention and reduction programs, in particular. Since classroom time is such a hard fought-for and scarce asset (Berliner, 2011), health advocates must learn to explain and persuade using educators' own vocabulary and standards, if they expect to receive classroom time and perhaps even school funding for school-based health initiatives.

In addition, curriculum theory is inherently long-term oriented. Curriculum design scholar-practitioners must ultimately consider spans of many years to achieve the knowledge and skills expected of school graduates. They can determine the appropriate curricular scope and sequence of content and experiences, coupled with the key curricular design tools of continuity, integration, articulation, and balance, in order to ensure that students develop and evolve their knowledge and skills adequately over time in reading/writing/English, math, the social and natural sciences, and hopefully in health, physical education, the arts, and other subjects requiring ongoing spiral education (Bruner, 1960/1977).

In contrast, in-school childhood obesity interventions have tended to be short-term, lasting on average less than a year (Zenzen & Kridli, 2009). In some cases this is due to scarce funding and classroom time. But it may also be due to underlying problems inherent in seeing school health interventions as a quick way to "cure" obesity, as if students could somehow be "inoculated" from future obesity. Instead, we need to admit that obesity is a deeply ingrained, complex behavioral epidemic, not comparable to a bacterial or viral

disease, which will require sustained multi-faceted learning through school curriculum and in many other ways, over years and decades, to help set individuals and communities on a better path.

Research Questions and Hypotheses

This study's primary research question is, what is the long-term impact of in-school curriculum-based exercise and nutrition programs intended to prevent childhood obesity? The study approaches the research question in part by evaluating the long-term impact of Operation Tone-Up, as one example of an in-school curriculum-based exercise and nutrition program that is effective short-term. The study's hypothesis is that participants in effective CO programs achieve substantial benefits in the short term, and that those benefits persist for up to several years. However, the impact of CO programs diminishes over time unless the program learnings are adequately reinforced.

A related question is, how does curriculum theory help us to evaluate the long-term impact of in-school nutrition and exercise interventions? The hypothesis is that curriculum theory indicates that one-time or intermittent interventions suffer from inherent weaknesses that undermine their long-term impact, including in their scope, in terms of inadequate duration; balance, in terms of little school time allocated relative to other subjects; continuity, in terms of lack of long-term repetition of key content and experiences; as well as deficiencies that stem from inadequate integration and articulation with the rest of school curriculum (Bracey, 2003; Ornstein & Hunkins, 2009).

Assumptions

This study assumed that students would remember if they participated in Operation Tone-Up and report this information accurately, and if not, that past participation could be determined from other data that students provided. It was also assumed that, given that OTU achieves material short-term results and uses some key curriculum theory and health psychology principles, which have a proven impact on habits, that there would be at least some residual long-term impact of OTU, and that the program was therefore worth examining as a CO prevention solution with potential longer term impact.

It was also assumed that potential confounding variables, that is, factors other than participation in the intervention that may influence health-related outcomes, could be identified. This study was designed to control for these variables so that valid study results could be obtained. Related to this, it was assumed that school employee interviews would help identify any critical school-based confounding influences that could lead to differences between former OTU participants and nonparticipants' knowledge, attitudes, and behaviors, resulting from non-OTU nutrition and exercise-related school policies and practices. In addition, it was assumed that out-of-school influencers, such as parental and family factors, as well as socioeconomic-related and sociocultural influences, and gender, would generally be controllable through confounding independent variables. Of course, other factors that were not assessed in this study may have influenced results. Nevertheless, the hypothesized associations have been shown.

Limitations

The current study uses a longitudinal retrospective design for comparing former Operation Tone-Up participants to peer non-participants in the same grades. Data from peer non-participants were used as the control. As a longitudinal retrospective study, the current study lacks some features of a traditional cohort, in which the exact same cohort of individual students is tracked and compared over time, beginning before the intervention is implemented. Since the present study did not involve traditional prospective randomized controlled trials (RCT), in which individual schools and students are randomly assigned in advance to either an intervention or control group, the generalizability of the results is reduced. Nonetheless, the study results, and conclusions which we can draw from them, provide valuable insights into the potential for improving health education and its long-term impact on individuals' health.

The effect of these limitations was reduced by surveying all students who provided informed consent in three sixth grade classes and broad cross-sections of middle school PE classes at two junior high schools. These schools receive students from many elementary schools with large populations of both Hispanic and non-Hispanic families, and low and middle income families, and from schools which did and did not participate in Operation Tone-Up over the past 6 years. Therefore, there is significant randomization, control, and longitudinality inherent in this study.

In addition, there are many influences on children's development, certainly in the area of nutrition, physical activity, and other health knowledge, attitudes, and behaviors, both in-school and out-of-school, that may have influenced the results. Attempts were made to control for the principal influences, including developmental, ethnic and socioeconomic

indicators, but certain potentially important out-of-school influences such as individuals' family demographics including parental education levels and occupations were not evaluated. In addition, while students were asked for information on ethnicity and free school lunch participation as an indicator of SES/income level, no attempt was made to try to identify the differential impact of other sociocultural elements on children's nutrition knowledge, attitudes, and behaviors. Nevertheless, by comparing large groups of students, who generally will have shared a range of in- and out-of-school influences, yet with Operation Tone-Up being a clear difference between them, and attempting to control for a range of recognized potential confounding variables, it is hoped that these limitations were adequately mitigated.

The study focused on relative rather than absolute behavior, that is, relative differences in behavior among the groups tested. No attempt was made to develop broad generalizations about detailed "universal" behaviors, for example, that middle school students who have not participated in effective interventions typically eat only X pieces of fruit per week, while former participants in effective interventions typically eat Y times as much fruit. Instead, the study focused more narrowly on contrasting intervention participants with nonparticipants, in order to establish whether their knowledge, attitudes, and/or behaviors were significantly different from each other, and therefore whether Operation Tone-Up appeared to have had a long-term impact on these variables, even if these groups' exact behavior is not clear or universally generalizable.

The sample in the current study consisted of 370 middle school students representing the ethnic and socioeconomic diversity of the community. The sample included boys and girls from grades 6, 7, and 8 from lower and middle income and Hispanic and non-Hispanic families. Students in the intervention groups participated in the CO program to varying

degrees, ranging from participating for multiple years including the current year, to having only participated many years ago. These factors played a variety of influential roles in students' nutrition and physical activity habits. As the sample was split by a greater range of these independent variables, it became more difficult to achieve statistical significance. Nevertheless, boxplots helped to show trends over time, even when statistical significance was weaker.

It was specifically requested orally and in survey instructions that students answer honestly, and was stated to students that honesty was t58he most helpful approach in our research. Nevertheless, social desirability bias may lead to biased responses, as students over or understate their self-reported attitudes or behaviors, in order to conform to peer, parent, teacher, or other social expectations (Neuman, 1991/2006). Just the same, there were signs that social desirability bias may have distorted intervention students' responses less than students in the control group, as discussed later. Student self-reporting relies on accurate student recall of key demographic information about past participation in the intervention, which elementary school(s) the student attended, and so forth, as well as student self-categorization including in regard to Hispanic ethnicity and receipt of free school lunches, and so on. These data may in some cases therefore be inaccurate.

Another limitation is that the long-term impact of one type of intervention, Operation Tone-Up, is being evaluated. This study's results cannot inherently be generalized to all in-school interventions, though these results may serve as an indicator for other in-school, curriculum-based, multicomponent interventions, which include effective nutrition education and rigorous exercise, and conform to other intervention best practices identified in the literature. Also, only grades 6-8 students' knowledge, attitudes, and behaviors are being

studied. No comparisons are attempted with groups of high school students or adults in order to review very long-term knowledge and behavior.

These and other limitations are discussed in more detail later, as well.

Reflexivity: the Researcher's Perspective

As a social entrepreneur acting as a "social innovation catalyst" to help address some of society's most important unmet needs, I am working on this issue, in conjunction with many others. As a practitioner, I have become involved in Accept The Challenge (ATC), a 501(c) 3 non-profit organization, whose Operation Tone-Up nutrition and exercise intervention in elementary schools has a proven short-term impact on children's health (Johnson, 2010; personnel and students of El Monte School District, personal communications, 2010-2011; personnel of Phoenix Area School District, personal communications, 2011-2012; Steen, 2011). In addition to attempting to help expand the program into more schools, I have been researching the long-term impact of Operation Tone-Up for this dissertation study. OTU has been implementing its current program model for over 10 years, typically in a range of ethnically diverse, low SE elementary schools in Arizona, California, Illinois, Texas, and elsewhere. These schools usually have significantly higher childhood obesity rates than the national average, just as adult obesity is highest among these ethnically diverse, low-income populations.

As a social entrepreneur, founder and president of Edunuity, my goal is to use social entrepreneurship to empower at least 100 million people by 2030 to significantly improve their lives, using innovative education-based solutions. In order to achieve this, Edunuity must devote the bulk of its time, effort, and investment to social enterprise models and policy

and practice initiatives that are highly scalable, extremely effective, very affordable, *and* sustainably self-funding.

My view in initiating this research was that, no matter what the results, whether they appear favorable to Operation Tone-Up or not, this study will provide valuable data and insights which will help efforts to reduce childhood obesity. At any rate, ultimately, no benefit can come unless the study is conducted with high integrity and rigorous research standards, so I have been committed to them throughout the study process.

I feel very comfortable that I can be objective, in spite of my involvement with OTU. Being objective, balanced, and conscientious is part of my temperament, and part of my mission as an academic researcher, for which Fielding Graduate University has prepared me (Bentz & Shapiro, 1998). There is clear evidence that it is possible and even desirable for scholars to be socially engaged and participating in the organizations which they are researching (Croteau, Hoynes, & Ryan, 2005; Herr & Anderson, 2005; Sanford & Angel-Ajani, 2006). In addition, Operation Tone-Up will be best served by the truth, whatever it is; if OTU is not having enough impact on long-term habits, then it needs to know that and address it, as best it can. And the study results on OTU's long-term effectiveness will also help me gauge, how much and in what manner, I should be involved with OTU or other health education programs as a "social entrepreneur" going forward. This study will also help me learn how I can be most effective in helping to address the obesity epidemic more generally, and the related issue of life skills education in schools, which is one of my key focus areas as a social entrepreneur. Nevertheless, it is important for me to disclose my personal involvement in Operation Tone-Up, my role as a social entrepreneur, and to be

mindful and accountable to my Dissertation Committee and the broader academic community about maintaining an objective research lens.

I have appreciated many aspects of the ways in which Fielding Graduate University approaches doctoral programs and dissertations. One example is that Fielding encourages the explicit use of the "I" voice, when writing up one's research. The vast majority of traditional academic writing in the social sciences seems to use the passive voice, or in other ways acts, almost as if the writer was not involved in the research, but is simply reporting on the research in an impersonal, objective manner. This approach highlights the researcher's aspirations for objectivity, but also exaggerates the researcher's ability to be totally objective. The passive voice seems to be trying to convey a sense of omniscience, as if virtually anonymizing the researcher raises him or her to an exalted status of accuracy and truth.

But Fielding believes there is more to be gained by admitting that both the researcher and the social sciences are imperfect. Instead, the researcher should disclose as explicitly as possible, "where he or she is coming from" personally, while also attempting to maintain objectivity as a truth-seeking social scientist with high academic integrity. Then let the reader decide what impact the researcher's particular perspective may have had on the reliability and validity of the research results. This approach is arguably a natural extension, for the same reasons, of the traditional requirement for the scholar to disclose his or her research design and methods as clearly as possible. By better understanding the "design" of the *researcher* as well as the research, and being clearer about the researcher's personal perspectives and roles, hopefully we are helping to enhance how social science research is conducted and presented, while making it a bit easier for the reader to decide, what weight to assign to the study.

CHAPTER TWO: REVIEW OF THE LITERATURE

Introduction and Overview

As noted earlier, this study's primary research question is, what is the long-term impact of in-school curriculum-based exercise and nutrition programs intended to prevent childhood obesity (CO)? This dissertation research study addresses this question by assessing the long-term impact of Operation Tone-Up (OTU). OTU is one example of an in-school curriculum-based CO prevention program, which is effective short-term, but for which the long-term impact has been unclear.

This chapter assembles and reviews a range of literatures important for understanding the problem of childhood obesity, and the nature and impact of school-based programs designed to address it. The theoretical framework for conducting this research is curriculum design theory. In this literature review, I initially discuss and review the limitations of behavioral and cognitive health psychology perspectives, which have been the dominant theoretical perspectives for school-based CO interventions to-date. These are contrasted with the value added from using curriculum theory as the primary theoretical lens. Curriculum design theory, in particular, is then used to critique existing nutrition and exercise programs in schools, which are intended to prevent childhood obesity. The literature review concludes with a discussion of the shortage of studies on the long-term impact of in-school CO prevention programs, and the resulting value of considering the long-term impact of Operation Tone-Up.

A broad review was conducted of in-school curriculum-based interventions intended to prevent and/or reduce childhood obesity, particularly programs during the school day at

the elementary school level, for all students—whether obese or not. Curriculum-based refers here to programs, which include structured materials and experiences, typically delivered wholly or in part in a classroom setting. Most CO programs seemed to attempt to reduce existing overweight conditions, while also preventing future obesity by developing healthy habits among all students. Since many interventions include all students in a particular class or grade level in the intervention, there also often appears to be a general though sometimes unstated goal of health and fitness improvement and the development of good nutrition and exercise habits among all participants, not just among overweight and obese children alone, in a particular grade level. Even though these interventions could be characterized more broadly as children's nutrition and physical fitness interventions or even children's health programs, rather than just CO prevention programs, this study and the health education community of practice usually refer to them simply as CO prevention programs.

Obesity and Overweight Context

Overweight and obesity are widespread now in lower income and ethnically diverse schools, and poor nutrition and lack of physical activity are even more pervasive. The definition of child obesity is different from that for adult obesity. For children, obesity is defined by the CDC (2012a) as BMI at or above the 95th percentile for children of the same age and sex, while overweight is defined as BMI at or above the 85th percentile and lower than the 95th percentile for children of the same age and sex. CO is 2-3 times higher in ethnically diverse, lower income communities (Wang & Beydoun, 2007). In addition, children with obese parents stand a much greater chance of becoming obese themselves (Herman et al., 2009; Kolata, 2007; Whitaker et al., 1997). Also, normal weight children, particularly from low socioeconomic status families, who may not currently be overweight or

obese, are often not physically fit and have poor nutrition (Gearhart, Gruber, & Vanata, 2008; personnel and students of El Monte School District, personal communications, 2010-2011; Steen, 2011). So even many non-overweight children are at-risk of obesity and unhealthy behavior later in life. As a result, a large percentage of students in lower income, ethnically diverse schools need significant nutrition and exercise improvement. In this environment, when such a large percentage of students are at-risk of developing unhealthy habits, it does not seem to make sense to try to identify which students to target and which to ignore. As a result, CO interventions often include all students at lower income, ethnically diverse schools, and try to improve overall nutrition and fitness habits, rather than just focusing on obesity reduction for currently obese students. The literature review was focused on these broader types of interventions, in particular.

The principal theoretical framework for analyzing the existing literature and past interventions was curriculum theory (Ornstein & Hunkins, 2009; Schiro, 2008), particularly curriculum design theory (A. Brown & Green, 2011; Ornstein & Hunkins, 2009). Curriculum theory addresses how to plan, develop, implement, and evaluate learning effectively. It is an interdisciplinary perspective, which includes significant and diverse philosophical, psychological, and sociological elements. Curriculum design theory addresses, in particular, how to develop and structure learning in an optimal manner. The key elements are scope, sequence, continuity, integration, articulation, and balance, as discussed in more detail below.

Let us first review theoretical frameworks commonly used for CO interventions, before looking at curriculum theory in more detail. We will then look at a broad range of anti-obesity interventions in elementary schools to assess their effectiveness, including how

they function from a curriculum theory perspective. We will conclude by considering the limitations from lack of long-term evidence of interventions' impact, and the resulting need to study long-term outcomes, and give a brief overview of the particular intervention studied, Operation Tone-Up.

Common Intervention Theoretical Frameworks

In spite of curriculum theory's inherent alignment with schools, the vast majority of elementary-school-based childhood obesity interventions and evaluations of them in the literature use other lenses, and are evaluated using non-curricular perspectives. Behavioral, cognitive, and social-ecological theoretical frameworks are predominant. Let us briefly review typical health education-oriented theoretical frameworks being used in in-school obesity prevention interventions.

Behavioral psychology seems to be the dominant theoretical lens used for school-based CO interventions, at least at the elementary school level. Program developers and evaluators focus on assessing which stimuli, in the form of program activities, lead to desired responses, in the form of healthier behaviors by children. Interestingly, and disturbingly from a scholarly point of view, a systematic review of the literature revealed that a large percentage of interventions did not even discuss their theoretical foundations (H. Thomas, 2006). Many implementations focus more on finding out whatever works, with minimal overt theoretical lenses, though these well-intentioned scholar-practitioners are undoubtedly making unspoken theoretical assumptions in developing their interventions (Mezirow & Associates, 2000). These interventions appear primarily behavioral in their assumptions and approaches; what seems to matter is whether the intervention works, rather than what is happening within the child, family, and/or society to make it work (Schunk, 2012).

Nevertheless, there were only a limited number of interventions found, which were explicitly behaviorist, in terms of prominently using terms such as stimulus and reinforcement, including Devault et al. (2009), Epstein, Paluch, Kilanowski, and Raynor (2004), and Sallis, McKenzie et al. (1997).

The cognitive perspective seems to be becoming increasingly popular for use in nutrition and fitness interventions. This perspective focuses on how program activities can change children's internal thought patterns and processes, so that students make healthier decisions. These cognitively-oriented intervention researchers tend to focus on cognitive behavior change theoretical constructs such as goal setting, self-efficacy (Geller & Dzewaltowski, 2010; Sharma, Wagner, & Wilkerson, 2006) and "readiness to change." Relatedly, van Stralen et al. (2011) found that self-efficacy and intention are significant mediators of physical activity (PA) interventions. A few cognitively oriented interventions were more purely cognitive than social-cognitive, that is, they focused more on the individual child as independent agent. Nevertheless, most used a broader social-cognitive perspective, seeing the child's cognitive development in the context of a family with one or more parents. Indeed, Leviton's (2008) review notes the danger in focusing only on individual thinking and behavior and ignoring the child's environment, in which her/his decisions are heavily influenced and circumscribed by parents, rather than made as already autonomous individuals. Many others emphasize the value of including parents in nutrition and fitness-related education (Ballard & Alessi, 2006; Kitzman-Ulrich et al., 2010; van Sluijs et al., 2011).

Nevertheless, while behavioral approaches seem well-accepted, certain more cognitively-oriented ones are still contested, at least at the elementary school level. McClain,

Chappuis, Nguyen-Rodriguez, Yaroch, & Spruijt-Metz (2009) found in their literature review of correlates of dietary intake among children and adolescents that, while cognitive measures such as dietary modeling and intentions were most supported, and to some extent, norms, liking, and preferences were supported, on the other hand, availability, knowledge, outcome expectations, self-efficacy, and social support "did not show consistent relationships" (p.1). As a result, McClain et al. (2009) went so far as to claim that "theory-based interventions that are guided by relevant behavioral theories are most likely to significantly impact dietary behaviors in youth" (p.2). Jurg, Kremers, Candel, van der Wal, and DeMeij (2006), after first believing that a cognitively-based approach was important, observed the results of their JUMP-in intervention among grades 4-6 students, and declared that "changes in behavior can be realized without first changing the cognitive determinants of that behavior" (p. 327). Indeed, it could be that elementary school and earlier interventions, which depend too much on children's self-efficacy may therefore have limited effectiveness and even be self-defeating. This is particularly the case, as discussed further below, when sociocultural factors, such as Latino parents' sometimes more authoritarian parenting style, may further limit children's choices (Gallegos, 1987).

Many researchers end up taking a hybrid, behavioral-cognitive approach. Della Grave, Calugi, Centis, Ghoch, and Marchesini (2011) concluded that "the key role of cognitive processes in the failure/success of weight management suggests that new cognitive procedures and strategies should be included in the traditional behavioral treatment of obesity, in order to help patients build a mindset of long-term weight control" (p. 1). They recommend hybrid "cognitive-behavioral strategies to increase adherence to exercise," including multidisciplinary interventions. Some interventions (Beckman, Hawley, & Bishop,

2006; Topp et al., 2009) have used the multidisciplinary transtheoretical model (TTM), which provides a four-stage cognitive framework with behaviorist elements for understanding behavior development (Mason, Crabtree, Caudill, & Topp, 2008; J. O. Prochaska, Johnson, & Lee, 1998). TTM involves the steps of precontemplation, contemplation, action, and maintenance: precontemplation, before an individual has considered changing behavior; contemplation, when the individual starts to think about changing; action, when the individual changes behavior; and maintenance, when behavior has changed but could revert unless steps are taken to continue with the new behavior.

Other theoretical perspectives, which CO interventions have used, include social-ecological theory, an increasingly popular one in childhood obesity, plus to a lesser extent critical social theory. (Some would consider these theoretical constructs to be broad conceptual paradigms rather than distinct theories; M. Guilarte, personal communication, December 5, 2011.) The social-ecological framework "hypothesizes a direct influence of environment on behaviour, i.e., unmediated by cognitive factors" (Jurg et al., 2006, p. 327). In a sense, though, interventions which involved parents as well as teachers and children, often seemed to operate at both the social-cognitive and social-ecological levels, whether or not the researchers acknowledged this. As noted earlier, this de facto "mixed theories" approach is utilized in many in-school anti-obesity interventions. Nevertheless, social-ecological theories are typically used in school-based CO interventions at the lowest "micro" level of the family and school, and do not typically expand upward into higher "ecological" levels to address government policies, corporate practices, and so forth (Bronfenbrenner, 1979). Jurg et al. and many other scholar-practitioners (Eichmann, 2011; Jansen et al., 2008;

Langille & Rodgers, 2010; Lent, Hill, Dollahite, Wolfe, & Dickin, 2010) use the social-ecological perspective, among other frameworks.

From a socioeconomic and ethnic point of view, as noted earlier, much of the obesity epidemic is occurring among lower income, African American and Hispanic populations. As a result, many interventions have been targeted at diverse, low socioeconomic special populations, though usually by targeting schools in diverse, low socioeconomic neighborhoods, rather than singling out special populations within schools. Given this differential social class and race-ethnic impact, human development and systems as seen through the lenses of sociology and sociocultural studies (Bronfenbrenner, 1979; Collins, 1994; Rogoff, 2003) are certainly relevant disciplines for a broader understanding of obesity's causes and how they can be addressed. In the area of childhood obesity, the social-ecological perspective points out the importance of including parents, public policy, and resources affecting school time allocation and instructional priorities, as well as public policy toward nutrition and physical activity inside and outside school. This includes infrastructure and security related to walking to school and exercising, healthy food availability in local stores, and broader public issues including food promotion restrictions, food distribution, and food- and beverage-related taxes.

While noting the risk in having systemic and difficult to change sociocultural concerns dominate intervention considerations, the sociocultural context perspective is an important part of human development (LeVine et al., 1994; Rogoff, 2003; Seymour, 1999). The CO scholar-practitioner must keep in mind the social aspects most likely to impact children, who are learning how to improve their health and fitness in schools, in the context of parental relationships and interactions, as well as unique sociocultural characteristics in

special populations with high obesity rates. Certain ethnic or other sociocultural aspects may contribute to obesity, and should ideally be addressed to maximize the effectiveness of in-school anti-obesity programs. On the other hand, other sociocultural elements could potentially help in obesity prevention.

Hispanic Populations

As the nation's largest minority ethnicity, with a relatively young population, lower household incomes, and high adult obesity rates, Hispanic children account for a significant percentage of obese and overweight children. Approximately 43% of Hispanic children ages 6-11 are overweight or obese, compared to about 35% of all non-Hispanic White children of the same age (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). To reduce childhood obesity substantially, CO prevention approaches must also be effective among Hispanic families. There are a variety of promising paths, as well as pitfalls (Draper et al., 2010; Hollar, Messiah, et al., 2010; Robinson et al., 2010; Tsai, Boonpleng, McElmurry, Park, & McCreary, 2009). For example, might Hispanic family dynamics, where there may traditionally tend to be a more authoritarian father figure, impede some children from successfully pressuring their parents to change what children are fed, much less pushing the parents to change parents' own behavior (Gallegos, 1987; P. Gallegos, personal communication, January 2013)? Parents and their parenting styles, including their eating and PA habits, have been found to have a significant impact on children's eating and PA habits (Savage, Fisher, & Birch, 2007). Kitzman-Ulrich et al. (2010) reinforce this concern by noting that family ethnicity may influence parenting styles and family functioning due to cultural differences in family systems variables such as family structure and intergenerational value (McGoldrick, Giordano, & Garcia-Preto, 2005). Both authoritarian and permissive

parenting styles have been associated with higher children's BMI in general (Power, Bindler, Goetz, & Daratha, 2010). Specifically, authoritarian parenting is associated with heavier weight Hispanic girls (Arredondo et al., 2006), while both authoritarian and permissive parenting are associated with heavier weight Hispanic boys (Berge, Wall, Bauer, & Neumark-Sztainer, 2010; Hughes et al., 2011).

There had been a tendency to attribute authoritarian Hispanic parenting styles to Mexican cultural norms of respect for authority; however, a 2004 study (Varela et al.) questioned that understanding. Varela et al.'s research comparing native resident Mexican, Mexican U.S. immigrant, Mexican American, and non-Mexican American "Caucasian" families in the U.S. attributed authoritarian parenting more to the minority ethnicity immigrant experience than to Mexican sociocultural values.

Whatever the case, a review of the research literature indicates that CO interventions and other CO prevention and reduction measures should take into account the existing body of research on parenting styles and Hispanic family dynamics. CO measures should steer parents toward authoritative parenting styles, and away from the extremes of authoritarian and permissive parenting, while also educating parents about good nutrition habits (Berge, 2009; Kitzman-Ulrich et al., 2010). At any rate, it appears that, while ethnic and larger sociocultural issues are important to consider in CO interventions, more generic psychological elements need to be effective as well.

Curriculum Theory as an Alternative Theoretical Perspective

None of the CO interventions found for this review claim that they are based on curriculum theory. Yet given the extreme sensitivity to taking vital classroom time away

from academics (Evenson et al., 2009; personnel & students of El Monte School District, personal communications, 2010-2011; personnel of Phoenix Area School District, 2011-2012), the more that CO prevention is integrated into the standard school "core" curriculum, and seen as reinforcing and enhancing the core curriculum rather than distracting from it, the better received it should be. (By core curriculum is meant reading, writing, math, and the social and natural sciences typically taught in elementary and middle schools.)

Bridging from current childhood obesity intervention theoretical frameworks into curriculum theory is not difficult. Indeed, salient elements of psychology, which apply to CO research and practice generally, have been incorporated as well into education and learning theory (Schunk, 2012), and in turn incorporated into these theories' application through age-and-stage-appropriate curriculum and instructional design theory (Ornstein & Hunkins, 2009; Richey, Klein, & Tracey, 2010; Schiro, 2008). In order to maximize effectiveness, and to reassure school personnel, school-based, and particularly curriculum-based anti-obesity programs should use curricular design principles proven effective for elementary school children. From the point of view of the curriculum and instruction community, this also brings the discussion from a more general and abstract, psychology- and health-oriented emphasis, to a closer-to-home, more familiar and comfortable, and more directly relevant educational theory and practice emphasis, in educators' own language and community of practice. In order to penetrate much larger numbers of schools, it seems that CO interventions should increasingly factor in curriculum theory as one of their theoretical frameworks. What are the key elements of curriculum design theory?

Scope refers to the curriculum's breadth and depth of content. It includes all of the topics, activities, and other content and learning experiences in the curriculum, including

cognitive, affective, psychomotor, and even moral or spiritual learning (Ornstein & Hunkins, 2009, p. 186), including their duration. Sequence is the pattern of content and experiences in the scope needed to achieve learning goals. Learning must build on what came before to provide continuous, cumulative education (Bruner, 1960/1977; Goodland & Su, 1992/1996). Continuity is the repetition of curriculum components over time to reinforce previously learned content and skills. This typically involves adding broader and deeper material later, which is related to previous learning, in a spiral fashion (Bruner, 1960/1977, pp. 52-54), not simply repeating exactly what came before. Integration refers to linking knowledge and experiences horizontally across the entire curriculum, in order to promote unified rather than siloed or subject-matter-only learning. Articulation is related to sequence and integration, and refers to the interrelatedness of various parts of the curriculum, both across subject matter (horizontally, e.g., connecting science and math) and over teaching time (vertically, e.g., connecting algebra to geometry). Balance involves giving the appropriate weight in learning time to each subject and other curricular elements.

The curriculum design elements described above are typically brought together in one of three basic design approaches: subject-centered, learner-centered, or problem-centered (Ornstein & Hunkins, 2009, pp.190-191). Yet even in a subject-centered curriculum design focused on individual subject disciplines, CO programs can link their objectives to academic standards in reading, writing, math, sciences, health, the arts, and/or PE, so that they reinforce and support discipline-based teaching. In addition, by relating exercise and nutrition to students' own personal life experience, CO programs can clearly conform to learner-centered curriculum designs. Finally, CO programs are self-evidently compatible with problem-centered curriculum design, which concerns itself explicitly with addressing

social problems (Ornstein & Hunkins, 2009, p. 206). Therefore, there is no need for CO advocates to align solely with one curriculum design perspective, and take sides in ideological "curriculum wars," since CO prevention can be effective using each approach (Ornstein & Hunkins, 2009; Richey et al., 2010; Schiro, 2008; Schunk, 2012).

In addition, there is a strong argument in favor of integrating more elements into the core curriculum, which are related to students' day-to-day lives. Student engagement is a proven educational strategy (Oczkus, 2009). It becomes even more important as students get older, and more bored, and wonder what the point of their schooling is. Exercise and nutrition present an opportunity to relate readings, writing assignments, math problems, science concepts, and so on, to students' lives in captivating, personally relevant, and socioculturally appropriate ways. This in turn can reinforce core academic concepts and skills, which schools need to teach anyway, yet are in many cases struggling to communicate effectively.

There is an additional major advantage to bringing curriculum theory into the CO prevention arena. One of the biggest problems with the current academic discussion of childhood obesity is that it is happening among health-oriented professionals in health-oriented journals. In this literature review, no evaluation of a school-based CO intervention was found in an education-oriented journal, except for health education journals targeted toward school health professionals. Health educators appear to live in a world apart, outside the academic mainstream in school systems, separate from core subject curriculum and instruction personnel (Lave & Wenger, 1991; Wenger, 2009), perhaps even seeing themselves more as public health educators than school teachers (Perales, 2012). In other words, the CO scholar-practitioner community seems to be "preaching to the choir" of those

who already believe in health promotion, in general, and in schools, in particular. As a result, they are neither addressing nor reaching the school curriculum decision-makers and gatekeepers, who are still skeptical about CO interventions, given their overriding academic mission, core curriculum focus, and "fixed pie" classroom time mindset (Berliner, 2011). It is ironic that many CO scholars and practitioners concur that multidisciplinary solutions are needed to combat the complex obesity epidemic, yet the potential to include the curriculum and instruction academic community in the discussion, and thereby help win them over, seems largely to be ignored in CO-related academic journal discussions.

Health educators could probably help their own cause more, by building "bilingual" cross-disciplinary bridges to curriculum and instruction personnel and their administrators, who will remain the gatekeepers and co-shapers of any CO- and health-related curriculum in schools. By using curriculum theory to structure and explain their CO prevention approach to curriculum personnel and school leaders, health educators could be more persuasive to them, and able to embed their health education programs better within the core curriculum. By going beyond good scope and sequence, and expanding integration, articulation and balance, including support for "common core" curriculum standards, CO prevention programs and other key health education and life skills programs may dramatically increase their classroom time allocation, in terms of scope/duration, continuity, and balance, and therefore their impact, while also helping schools to engage students more in school and to meet core curriculum standards and testing goals. All of these aspects are needed for long-term, ultimate success in preventing obesity, while still also building critical thinking and other academically related capabilities. These steps should help to reduce education leaders' fears that precious class time is being spent on non-core areas that distract from core

achievement goals. Also, by maximizing student engagement and synergies across the curriculum, health educators can be even more persuasive to curriculum decision-makers. After all, the ultimate, mutually shared goal is for schools to help all students to develop the capability to be successful in life.

Health Psychology-Based Interventions and Curriculum Theory

Let us review briefly how curriculum theory improves on health learning psychology alone, in regard to CO prevention interventions in schools. In a sense, health education inherently requires appropriate scope and sequence. Both behavioral and cognitive perspectives assume that a range and schedule of activities are needed to produce certain health knowledge and behaviors. What is more, adding a cognitive perspective arguably brings in more dimensionality and sophistication than a purely behavioral approach, and allows interventions to address later human development stages more effectively (Goldhaber, 2000; Piaget, 1950/2001), including the development of more advanced health-related critical thinking. In either case, health learning design still requires listing a scope and sequence of content and learning experiences.

Nevertheless, curriculum design theory goes beyond the health learning psychology framework in a number of respects, when it adds into the mix the concepts of continuity, integration, articulation, and balance. This is particularly true, when curriculum theory is applied within the framework of a broader multi-year school curriculum scope and sequence, in the school environment. In these cases, continuity, integration, articulation, and balance become even more broad, deep, and complex.

From the point of view of the existing curriculum in a school, a CO intervention, which is not an integral part of the school curriculum, represents a random, stochastic

imposition, which teachers must somehow fit into the existing curriculum. In addition, if the CO intervention does not follow the standard curriculum design elements and approach of the rest of the curriculum in developing and implementing the intervention, teachers are likely to be left with some gaps, for which they need to compensate. For example, they may need to develop materials and activities on their own, and try to connect them to other school curriculum elements. This requires additional time and attention, which teachers typically do not have. What is more, unless the intervention provides additional material for follow-up, and the time, energy, and commitment are available later to continue the CO prevention education process, the chance for reinforcement through continuity is very limited. Without repetition and reinforcement later, behaviors learned are likely to taper off over time and then disappear (G. S. Reynolds, 1968, pp. 28-34). Indeed, with all of the pressures on classroom time, even foreseen follow-ups may well never occur, especially since few intervention organizers stay involved on-campus following program implementation, or measure program impacts for more than a few months afterward (Fjeldsoe et al., 2011).

This brings us to integration, articulation, and balance. A review of a range of CO interventions indicates that they have rarely, if ever, been contemplated by the school district's curriculum and instruction department as an integral part of the school's overall curriculum design. While the more school-friendly interventions have designed their material to align with national and state academic standards, teachers typically need to integrate and articulate intervention materials with their standard subject lesson plans themselves, or else treat them as a separate curricular component. In either case, integration and articulation are limited and suboptimal. CO interventions do undoubtedly bring some balance to an otherwise heavily academic core-oriented curriculum, by adding nutrition

and/or PA learning to the mix. However, the balance shift is temporary, only lasting as long as the intervention. Unless special efforts are made to maintain elements of the intervention, the school's curriculum tends to return to its original (im)balance, and continuity and long-term balance are inadequate.

Review of Prior Interventions in Schools

Several themes and issues stand out after reviewing research on a large number of school-based interventions, and systematic reviews of them. These include the advantages of mandatory, school-based, nutrition-plus-PA multicomponent programs, and rigorous exercise, supplemented by parental involvement, as discussed in more detail below. Also of note are the importance of targeting the right populations including girls with the right programs (Bogle & Sykes, 2011; Carlson et al., 2008; Datar & Sturm, 2006; Sallis et al., 2003; N. E. Thomas et al., 2010); the importance of academic performance and the potential for nutrition and exercise to improve academic outcomes, and thereby help gain access to schools (Chaddock, Erickson, Prakash, Kim, et al., 2010; Chaddock, Erickson, Prakash, VanPatter, et al., 2010; Dishman et al., 2006; Hillman, Erickson, & Kramer, 2008; Hillman, Snook, & Jerome, 2003; Hollar, Messiah, et al., 2010; Jarrett et al., 1998; London & Castrechini, 2011; personnel and students of El Monte School District, personal communications, 2010-2011; Pontifex & Hillman, 2007, 2008); and related evidence that time spent on physical education and physical activity does not harm academic performance (Trudeau & Shephard, 2008, 2010).

These positive aspects contrast with the weaknesses of recess (Adams, 2011; Bogle & Sykes, 2011; Carlson et al., 2008; Jarrett et al., 1998; Sallis et al., 1997; Schaefer, 2011; Williams & Mummery, 2011), of traditional PE (Hoelscher et al., 2004; Trudeau, 2008), and

of many (though not all; de Heer, 2009) after-school programs (Branscum & Sharma, 2012; Wilson et al., 2011) , as well as deficiencies of single component and information-only approaches (Beckman et al., 2006, p. 266; Caballero et al., 2003; McClain et al., 2009). Additional intervention issues include: age-and-stage (Ornstein & Hunkins, 2009; Richey et al., 2010; Schiro, 2008), analytical (DeVault et al., 2009), statistical (Maniccia, Davison, Marshall, Manganello, & Dennison, 2011), and theoretical deficiencies of a number of interventions and systematic reviews; failures to consider intervention costs and funding (Erwin, Beighle, Morgan, & Noland, 2011; Haynos & O'Donohue, 2011; Laitsch, 2009; K. D. Reynolds & Spruijt-Metz, 2006; Stewart-Brown, 2006; Xin & Yanhong, 2004); the limitations of public policy to-date (Evenson et al., 2009; Madsen, 2011); and the lack of evidence to-date of long-term, cost-effective, sustained results for CO interventions (Hilbert et al., 2008; Laitsch, 2009).

School-based Programs

Many scholar-practitioners, including those who have systematically reviewed childhood obesity interventions, have found in-school curriculum-based programs to be particularly effective. Such formats have been used effectively for a range of public health and safety challenges in other areas, including to increase safety belt and bicycle helmet use (Azeredo & Stephens-Stidham, 2003), and to help reduce the likelihood of tobacco use (Jepson et al., 2010). In addition, physical activity-oriented curriculum provides valuable structure and discipline typically absent from recess and other unstructured physical activity, including much of traditional PE (Hoelscher et al., 2004). Curriculum also provides structure and materials to teachers, who often lead CO interventions in the classroom, and do not have time to develop such materials themselves. Teachers have their hands full just trying to fit

health education in alongside the academic core (Evenson et al., 2009; personnel & students of El Monte School District, personal communications, 2010-2011; personnel of Phoenix Area School District, 2011-2012), without having to determine CO prevention education scope, sequence, and so on, as well.

These conclusions also reinforce Veugelers and Fitzgerald's (2005) finding, after surveying thousands of students, parents, and principals involved in CO interventions, that school-based nutrition and PA programs work. As summarized by Zenzen and Kridli (2009), in-school curriculum-based programs "may (1) enhance learning and provide social benefits, (2) enhance health during critical periods of growth and maturation, (3) lower the risk for chronic diseases in adulthood, and (4) help to establish healthy behaviors at an early age that will lead to lifelong healthy habits'' (p. 434). State health department chronic disease directors agreed that school-based approaches were the highest priority for preventing CO (Leviton, 2008). In addition, a range of school stakeholders "agreed that schools are a crucial setting to implement CO prevention strategies" (della Torre, Akre, & Suris, 2010, p. 233). Schools provide a "captive audience" made up of virtually the entire school-area community of a certain age. Wang and Beydoun (2007) concluded their comprehensive analysis of obesity trends in the U.S. by stating, "because the majority of children spend many of their waking hours in schools, schools should be key partners in the prevention of childhood obesity" (p. 24).

There is also substantial support for having all children at lower income and even many middle-income schools participate in CO prevention and health education, rather than targeting particular at-risk populations within schools. Many children are normal weight but are not fit, engaging in little or no physical activity, and often having bad nutrition habits

(DuBose, Eisenmann, & Donnelly, 2007). Lack of fitness in spite of being normal weight creates a serious health risk, with about 40% of "thin but unfit" adults having metabolic dysfunctions (Lustig, 2013; Weiss et al., 2013). Indeed, there is growing evidence that being normal weight yet unfit has similarly negative long-term mortality consequences to being obese yet fit—the so-called "thin but unfit" vs. "fat but fit" health outcomes comparison (Matheson, King, & Everett, 2012; McAuley, Pittsley, Myers, Abella, & Froelicher, 2009). Also, many children are normal weight now, but at-risk of becoming overweight or obese in the future, especially when one or both parents are obese (Whitaker et al., 1997). Furthermore, parental overweight and obesity have become common in middle as well as lower income families, given that two-thirds of Americans are now overweight or obese. Doing the math on this, given that only about one-third of adults are normal weight, and of those approximately 40% have metabolic dysfunction (Weiss et al., 2013), and comparing these estimates to others, the implication is that only about 20-25% of adults are both normal weight, fit, and without metabolic dysfunctions (Duncan, 2010). By implication, only a small percentage of lower income American families have both parents normal weight, fit and without metabolic dysfunctions. In order to improve people's health, children with bad nutrition and PA habits, or who are at-risk of developing them, whether they are normal weight, overweight, or obese, must develop healthier habits. When one adds up the health risks facing lower income students, and even many middle-income communities, there is substantial support for making effective nutrition and fitness education broadly required in schools (CDC, 2013a).

We now turn to the topic of which intervention characteristics are most effective in schools.

Intervention Best Practices

Laitsch (2009) cites a range of research that multicomponent, "comprehensive programs that address mental health, healthy eating, and physical activity…have been found to be effective in promoting change" (p. 274). Kriemler et al.'s (2011) meta-analysis of PA interventions and reviews also showed the importance of multicomponent interventions, with parents involved as well as school-based exercise and nutrition education: "Taking into consideration both assessment quality and public health relevance, multicomponent approaches in children including family components showed the highest level of evidence for increasing overall PA" (p. 923). The British Nutrition Foundation, in spite of its mission focus on nutrition, recommends that both physical activity and home economics education be included in school curricula (Barbie, 2004). Further support for combining nutrition and PA in CO interventions is provided by physiological evidence that good nutrition is needed for sustained vigorous exercise, while deficiencies in nutrition may limit improvements from PA (Anding, 2009). Nevertheless, many programs continue to focus on nutrition or physical activity, but not both, in spite of the evidence in favor of multicomponent approaches.

The value of multifaceted, integrated approaches is foreseen in curriculum design theory, in its focus on the combination of scope, sequence, integration, articulation, and balance, as well as continuity. For example, multicomponent designs enable synergies implied by the curriculum theory elements of integration, articulation, and balance. In contrast, single-component interventions, such as PA-only interventions that ignore nutrition, or nutrition interventions that ignore PA, are not well supported by curriculum theory. Therefore, single-component interventions' deficient outcomes should not be surprising; what is more surprising is that single-component interventions continue to be implemented.

It appears that this tendency may often be related to the particular expertise and personal "comfort zone" of the intervention developer, rather than what the school and students need. This may be another example of how community of practice siloes are endangering the impact of CO interventions.

Nutrition is a critical part of the scope of a CO intervention. Nutrition can arguably be even more important than physical activity in preventing obesity, in part because it is hard to engage in the hours of PA required to burn off the 500-1000+ excess calories typical for many overeaters (Anding, 2009; Katan & Ludwig, 2010). The type of food eaten and the amount of calorie intake can have a significantly bigger impact on obesity than physical activity. In terms of dietary intake, one study (Hattersley et al., 2009) found that many parents find it feasible to reduce their children's sugary beverage intake, in contrast to parents' difficulty in reducing children's small screen time, and by implication the related challenge of turning foregone screen time into vigorous physical activity.

In addition, studies show that obese parents tend to have obese children (Whitaker et al., 1997). So school nutrition programs that also involve parents can enlist them to reduce children's caloric intake, while also helping parents learn how to improve their own nutrition. This parental link is supported by social-ecological theory, as noted earlier, but also by the integration and articulation principles of curriculum theory, which can accommodate non-school learning experiences and bring them into the program's scope and sequence.

In-school physical activity is an important element in CO prevention interventions. Katz's (2009) review of school-based health promotion and weight control interventions showed that they had significant effects on weight, and Jansen et al. (2011) found a "growing body of evidence that school-based programs with a focus on physical activity are most

effective in reducing childhood obesity" (p. 1). Kriemler et al. (2011) analyzed recent reviews and randomized control trials (RCTs) conducted from 2007-2010 for school-based interventions with a physical activity or fitness outcome, and found that "school-based interventions are thought to be the most universally applicable and effective way to counteract low physical activity and fitness" (p. 923). These conclusions back up Stewart-Brown's findings (2006) that school programs which promote mental health, healthy eating, and physical activity tend to be more effective compared to other health-oriented interventions.

Nevertheless, rigorousness and structure of exercise in terms of time and intensity is important, not mere physical activity. Metcalf et al. (2011) found that body fat percentage predicts reduced PA, but PA alone, regardless of rigor, does not predict body fat percentage. Rigor should be defined clearly and factored in as part of the curricular scope and sequence. (Rigorous physical activity here means PA, which elevates the heart rate and stresses key muscle groups significantly enough to materially improve resting heart rate and blood pressure and build muscular strength, similar to the standard usage of "vigorous" PA.) Children who do not normally tend to be active, such as overweight and obese children and normal, overweight, and obese adolescent girls, tend to stay inactive and unfit unless they are required to become active through structured programs. For example, a Physical Activity Across the Curriculum (PAAC) intervention saw increasingly positive impact on BMI as the amount and vigor of PA increased. In particular, participants who exercised moderately to vigorously (MVPA) for 75 minutes or more per week experienced significantly less of a BMI increase (Donnelly et al., 2009). Laitsch (2009) cites a range of research supporting the need for "high intensity" interventions to promote change. Reynolds and Spruijt-Metz

(2006) state that "it is clear…that stronger interventions are needed" (p. 237). Moderate to vigorous physical activity not only creates a prolonged positive metabolic effect in burning calories, beyond just the calories burned during the PA itself; it also builds calorie-consuming lean muscle mass (Brambilla, Pozzobon, & Pietrobelli, 2011), which burns substantial calories even when at rest (Anding, 2009).

In many school districts, the increasing focus on academic results has also reduced or eliminated PE (Trudeau & Shephard, 2008). However, it is not surprising that PE has had trouble making a strong case for its contribution to academic performance. It clearly uses up time that could theoretically be used to improve academic results. In addition, traditional PE has underperformed its potential and hurt itself, by lowering its expectations and its rigor (Hoelscher et al., 2004). PE has often been loosely structured and not very rigorous in the past, and therefore not aerobic enough in many schools for sufficient numbers of students to substantially improve fitness and enhance academic performance, as discussed later. Leviton (2008) notes that even if PE were universal, "merely having physical education is not sufficient" to prevent obesity (pp. 42-43). PE professionals will need additional professional development to reinvigorate PE and maintain its relevance in an era of a predominant academic focus (Hoyle, Bartee, & Allensworth, 2010).

In regard to physical activity, data from a range of research show that girls tend to be substantially less active than boys (Williams & Mummery, 2011), yet they are susceptible to similar health and academic issues from obesity. Girls who enter kindergarten overweight or become overweight in the early years of school, in particular, have a significant risk factor of adverse school outcomes (Datar & Sturm, 2006). In addition, girls as a whole appear more resistant to increasing physical activity than boys (Sallis et al., 2003). For example, N. E.

Thomas et al. (2010) found that, even though their intervention had recommended one hour per day of physical activity, 80% of girls did not meet that goal. On the other hand, as might be expected from the particularly strong impact of interventions on the most overweight, many interventions with a PA component have noted a significant improvement in girls' PA levels, even if boys' levels did not change dramatically (Bogle & Sykes, 2011; Carlson et al., 2008). The importance of including girls in obesity prevention programs adds further credence to the value of having all students participate in interventions, rather than singling out certain groups.

In brief, evidence from the literature supports the value of in-school, curriculum-based CO interventions for all students including normal weight children and all girls, which are multicomponent, require rigorous exercise, and ideally also involve parents. As discussed in more detail later, Operation Tone-Up has these characteristics, and has demonstrated short-term results during and shortly after implementation, which indicate that the intervention has an immediate impact. But what is the longer term impact of in-school curriculum-based CO interventions, including Operation Tone-Up?

Lack of Long-Term Evidence on CO Interventions

Current research typically reviews programs' impact pre- and immediately post-program. On the positive side, Laitsch (2009) cites CDC and other research (Keirle & Thomas, 2000; Stewart-Brown, 2006; Veugelers & Fitzgerald, 2005) indicating that "comprehensive programs that address mental health, healthy eating, and physical activity, and that are long-term, whole school, and high intensity, have been found to be effective in promoting change" (p.24), though the definition here of long-term appears vague.

Following through later with evaluation and/or reinforcement helped to increase the duration of impact. Seventy-two percent (72%) of programs that assessed impact 3 months or more after completion achieved maintenance of their interventions. Fjeldsoe et al. (2011) also found that "interventions were more likely to achieve maintenance if they: were conducted over a longer period (>24 weeks); included some face-to-face contact; used multiple intervention strategies (>6); and included follow-up prompts (that is, brief contacts that occurred after the main part of the intervention to reinforce previous intervention content)" (p. 106).

On the other hand, there is little research on the enduring impact of programs in the years after implementation. Fjeldsoe et al. (2011) found that only 35% of programs assessed maintenance 3 months or more after completion of the intervention, and less than 12% included a follow-up assessment of 12 months or longer. Many interventions occurred only over several months or a year or two, which appears unlikely to generate a long-term behavior change that substantially improves children's health as adults. In a review of a number of interventions, Zenzen and Kridli (2009) concluded that the average duration of 10 months "does not appear to be adequate, especially in studies looking for outcomes related to changes in BMI" (p. 245). These interventions may be effective short-term and show promise for expansion in the future, but seem unlikely to have enough scope (in terms of duration of time) and curricular continuity for lifelong or even simply long-term impacts, by themselves, as currently implemented. Laitsch (2009) declares in his review of interventions, in part based on Centers for Disease Control and Prevention findings, that there is "not enough research available to determine the extent to which programs result in the longer term prevention or reduction of overweight" (p. 270). Hilbert et al. (2008) insist that "more

longitudinal risk factor evidence is warranted to inform future preventive approaches" (p. 23).

The importance of ongoing maintenance and follow-ups is well supported theoretically, by general behavioral and health psychology, as well as curriculum theory. Johnson-Askew, Fisher and Yaroch (2009) note a consensus among many scientists that "initiating behavior differs conceptually from sustaining behaviors" (p. S88). Just because a program is able to start behavior change, does not mean that the same approach can sustain behavior over time; new behavior will not automatically continue once started. Some sort of ongoing reinforcement or other additional learning seems essential to maintain behavior change over the long-term. This insight from health behavior psychology, particularly the behaviorist concepts of reinforcement and maintenance to prevent extinction (G. S. Reynolds, 1968), are in a sense incorporated into and automatically generated by curriculum theory's insistence on adequate scope and sequence (which includes program duration), balance (current time allocation relative to other subjects), and continuity (repetition and long-term follow-through). Even a brief break in a program may impede the persistence of new behaviors. Carrel, Clark, Peterson, Jens, and Allen (2007) note how the behavior of middle school students involved in an intervention had returned to previous levels after the summer break.

A related issue is the impact of in-school programs on out-of-school behavior. If out-of-school behavior does not change, this appears to significantly weaken the prospect for lifelong behavior improvement from school-based CO interventions. Kriemler et al.'s (2011) review of recent interventions found that "effects outside school were often not observed or assessed" (p. 923). As part of reviewing out-of-school and long-term impacts of CO

interventions, individuals' overall behavior must be understood, not just what is self-reported or observed at school. This further supports the value of parental involvement.

From a curriculum theory point of view, one of the most glaring omissions from CO prevention interventions and their evaluations to-date has been in the area of scope (in terms of duration) and continuity (in terms of repetition/reinforcement). Curriculum theory predicts, supported by behavioral psychology, general learning theory (Schunk, 2012), and common sense, that long-term impact requires long-term exposure in schools. Imagine society expecting students to learn to read and write or do math through a series of short-term, intermittent interventions without long-term, well-thought-through, and skillfully implemented follow-ups? In spite of this, Zenzen and Kridli (2009) calculate that the average CO intervention lasts only the equivalent of one school year. Indeed, it appears that only a very limited number of interventions documented in the peer-reviewed literature are conceived as linked multi-year interventions, with a curriculum that evolves developmentally over many years for the same cohort. Also, few if any programs reviewed extend from elementary to middle school, or from middle school to high school.

Curriculum theory encourages health education interveners to include critical long-term elements. By the same token, if nutrition and rigorous fitness education in schools were designed and operated as an ongoing part of the overall curriculum's design and implementation, instead of being implemented as a one-time program, longer term results should be more definitive and easier to achieve. From a curriculum theory perspective, nutrition and exercise curricula should continue and evolve spirally over many years, following Bruner's (1960/1977) spiral insights of "developing and redeveloping," and re-examining curricula "with an eye to the issues of continuity and development" (p. 54).

In spite of the lack of multi-year continuity and scope, and other curricular shortcomings described earlier, are CO interventions having a long-term impact on students' health-related knowledge and behavior in the years after interventions? One of the biggest, still missing pillars to help expand the in-school CO prevention movement is the lack of information on their long-term outcomes.

Looking further into the future than individual intervention evaluations have done, Trudeau (2009) highlights longitudinal data showing that PA as a child does not predict PA in adulthood, concluding that "no significant relationships between childhood fitness level and adulthood PA was found" (p. 329). On the other hand, on a promising note, an intensive summer camp for overweight children maintained its lower BMI trajectory almost a year after the summer camp had ended (Gately, Cooke, Butterly, Mackreth, & Carroll, 2000). Apparently, even a brief though rigorous program with the right scope, sequence, and so on, can have a degree of sustained impact, at least for a number of months, even when appropriate reinforcement and continuity is not provided. Nevertheless, almost all theory and evidence to-date makes it seem likely that newly learned positive behaviors are likely to weaken or disappear over time. Yet skepticism by educators, policymakers, and other decision-makers, funders, and gatekeepers seems likely to continue, until one or more interventions shows effectiveness over many years. As discussed later, resistance by educators may stem to a substantial extent from pressure on them to focus on academic test results in core subjects (Evenson et al., 2009), which are increasingly defined by multi-state common core standards and tests that do not include health education (National Governors Association Center for Best Practices - Council of Chief State School Officers, 2010).

On a positive note, even interventions with limited effects arguably are helping to lay the groundwork for long-term change. Even very broad and relatively shallow programs, such as the California statewide RE-AIM program to increase PA and improve nutrition, were considered by evaluators to have a moderate to high public health impact (Dunton, Lagloire, & Robertson, 2009). True, Madsen (2011) found that mandatory BMI screening in California with optional parental notification had no impact on BMI scores from 2001 to 2008 in itself, but the screening and notification seem likely to have at least raised awareness of the issue, providing more fertile soil for future learning, parental participation, and public support. Recently, Jenike, Lutz, Vaaler, Szabo, and Mielke (2011) used cultural domain analysis to study the "lasting influence" years later among high school students who had participated in an elementary school nutrition intervention. While these students' nutritional behavior was not significantly different from high school peers who had not been in the elementary school nutrition program, the elementary school intervention students grouped food and drink somewhat differently cognitively, demonstrating the continuing impact of the program they had participated in years earlier, and creating in Jenike et al.'s view, a foundation for healthier choices as adults. Jenike et al.'s study shows some of the subtle and not fully understood, yet important ways, in which education in childhood can impact future thinking and behavior. It also implies even higher potential for programs to influence thinking and behavior, when learning is both highly effective and sustained over time.

Drawing from the more effective ingredients of short-term programs to-date, if there were more programmatic continuity, not to mention more integration, articulation, and balance with the rest of school curriculum, coupled with developmentally evolved scope and sequence as student cohorts move up through grades, curriculum theory, health and

behavioral psychology, and common sense would predict significantly greater longer term outcomes. Nevertheless, to-date, no interventions have been developed, for which there is even a partial academic or practitioner consensus that they should become universal; the evidence is not yet there that any particular in-school CO prevention program should be implemented on a large national scale (Haynos & O'Donohue, 2011), to the exclusion of other in-school anti-obesity programs. Furthermore, the lack of evidence for sustained results creates uncertainty about the long-term impact of current intervention structures on behavior, and this lack of long-term data undermines support for interventions. Until interventions' long-term impacts are better understood, a consensus on which interventions to roll out nationally seems unlikely to emerge.

My dissertation's research in schools attempts to help remedy the lack of multi-year evidence by researching the long-term impact of Operation Tone-Up on middle school children, who participated in Operation Tone-Up in elementary school, up to 3-4 years after CO interventions at their elementary school.

Operation Tone-Up

How well does the Operation Tone-Up program (OTU) adhere to curriculum theory principles, and how can it improve in this area? Does it have a long-term impact on participants in its current form and implementations, in spite of limited duration and continuity? Operation Tone-Up has significant aspects, which are supported by curriculum theory, though it also has some similar shortcomings to those of other CO interventions, from a curriculum theory point of view. As for its long-term impact as it is currently structured and deployed, this dissertation research addresses that in the following chapters.

A recent version of OTU came with a comprehensive instructor's manual, including pre-made photocopy-able test instruments, and an engaging student workbook with large numbers of motivating text-to-self exercises, which have the student relate the nutrition and exercise information directly to her- or himself (Lamka, 2008-2012). The manual and workbook provide a clear and convenient scope and sequence for teachers. The text-to-self approach is based on well-accepted K-12 teaching principles to increase student engagement, by having the student relate the classroom material to the student's own life (Chicago Public Schools Office of Literacy, 2010). The Operation Tone-Up material achieves this throughout the program, by having the student-participant track her/his eating, drinking, and exercise habits, and how s/he feels.

This aspect of the program's scope is broadened further through the OTU physical exercises; as they become more rigorous, students can feel the importance of the different nutrients in sustaining their exercise effort. Students start with approximately 5-6 minutes of continuous vigorous aerobic exercise, and then work up to 20+ minutes of similarly intense, continuous exercise by the end of the 10-week intervention. In effect, this approach of having students themselves experience the link between nutrition and exercise also provides a powerful example of a student- and problem-centered curricular design foundation.

These student materials also parallel typical teacher's manuals plus workbook curricular materials for standard academic courses, and make it easier for the teacher to implement the program by providing ready-made scope and sequence in the form of structured materials and activities. In addition, a program DVD and CD are provided, which engage the student audio-visually with dynamic music. Children shown on the DVD model the exercises and show the students that the exercises are doable, in accordance with social

learning principles (Bandura, 1977). High-impact exercises were selected which can be performed in a compact space such as a classroom, under close supervision by a teacher. Creative, dynamic stories and cartoon characters are also used throughout all materials to get and keep students engaged (Oczkus, 2009).

Also, as a result of these automated media-rich materials, the instructor does not need to exercise as much as the students, if s/he is not willing or able to do so. Instead, the teacher can focus on ensuring students' participation and good exercise form, which maximizes impact. The culminating Fittest School Challenge inter-school contest also adds extrinsic motivation to the scope and sequence for students to exercise hard, so that they can possibly win the competition involving other schools at the end of the intervention (Lamka, 2012). OTU maximizes the class-wide impact of this contest, by randomly picking students from each class, rather than allowing teachers or schools to select the fittest students. So any student may be picked, and ideally all students should feel motivated to keep exercising and studying nutrition. In addition, OTU provides greater balance to the core curriculum, which has increasingly sidelined physical activity, health, and other "non-core" subjects.

Two third-party studies on the Operation Tone-Up intervention's short-term results have been conducted (Johnson, 2010; Steen, 2011). The first was carried out in 2010, and covered a series of 10-week annual interventions at elementary schools from 2007-2009. It was not a randomized controlled trial, but did provide some retrospective longitudinal evidence of major changes in objective pre- and post- metrics such as nutrition knowledge, strength, blood pressure, and resting heart rate. The second study involved a semi-randomized controlled trial, comparing 11 intervention schools to two control schools (though the second control school did not provide results). The school district selected two

representative schools as the control schools, and the Operation Tone-Up intervention was implemented at the remaining 11 schools. This second evaluation demonstrated a significant difference between the intervention schools and the one control school that reported results, with much better nutrition knowledge, blood pressure, and resting heart rate improvement at the intervention schools, on average. Average resting heart rate and blood pressure decreases in the 5-10% range were reported among intervention participants in both studies after the 10-week program finished (Johnson, 2010; Steen, 2011). Operation Tone-Up produced a range of effects similar to other rigorous multicomponent programs. OTU-participating students, who were in the worst shape, including the children with the highest BMI, improved their blood pressure and resting heart rate by up to 10% or more in just 10 weeks. This was a substantially bigger improvement than for lower BMI students, as would be expected from the literature. In addition, Operation Tone-Up was implemented in the Chicago public school system when current U.S. Secretary of Education, Arne Duncan, was CEO of Chicago Public Schools. The Operation Tone-Up Web site provides a link to an endorsement of OTU by Secretary Duncan (NBC, c.2010).

One reason why OTU appears to be effective, and to have been accepted by a number of schools, is that it already makes use of many accepted curriculum and instruction principles, aligns with a number of academic standards, and acknowledges many classroom practicalities. Indeed, OTU's attention to curriculum theory elements appears to have been a key part of Operation Tone-Up's effectiveness and acceptance into schools. In Operation Tone-Up's case, its adherence to curriculum theory came indirectly, largely by listening to input from teachers, rather than by intentionally applying curriculum theory (Tony Lamka, personal communications, 2010-2012).

OTU's learning objectives are linked with national academic standards in reading, writing, math, health, and PE (Tony Lamka, personal communications, 2010-2012), making the program's objectives supportive of and partially integrated and articulated with the core academic curriculum, as well as recognizing the importance of subject-centered curricular design theory. In addition, the entire program reflects a problem-centered design theory framework, too, in that it is clearly focused on helping students become fit and healthy. OTU also is highly learner-centered, and uses cartoon characters, text-to-self student work, dynamic exercise music, and other strategies that engage students. The program's scope and sequence is broad and substantive, yet brief enough to fit into a 10-week duration.

While Operation Tone-Up employs curriculum theory principles, de facto if not explicitly, the program has some material shortcomings, too, from a curriculum theoretical perspective. While workbook tasks link to reading, writing, math, science, health and PE academic standards, thereby connecting to and reinforcing core subjects, there are not detailed linkages to particular school district reading, math, and other core textbooks and curriculum. Instead, these must be provided by teachers. So there is some integration and articulation, but it is not yet optimal. This will tend to be a shortcoming of any intervention, which is brought in as a separate experience, rather than as an integral part of the overall school curriculum. Another problem is that the same intervention curriculum is used for all elementary grades. This means that some aspects of the OTU curriculum are bound to be nonoptimal developmentally. Also, students who have been in the program for several years may become bored with the same materials and experiences. Accept The Challenge recently added some exercise routines, consisting of new music and video footage, to help address this (Tony Lamka, personal communications, February 17, 2012 & May 13, 2013). Accept

The Challenge notes that its multi-grade program is "designed to teach children how to get into shape, and requires children of all age levels to complete the OTU Basics program first, to develop proper exercise form and know about the nutrients, before advancing to the next level" (Tony Lamka, personal communications, May 13, 2013).

In addition to this focus on the student, the social-cognitive and social-ecological perspectives emphasize the role of parents in influencing children's behavior, as described earlier. These theories strongly encourage us to broaden our interpretation of curriculum theory to include students' parents, and expand scope and sequence to include them. Since Operation Tone-Up is already achieving significant evidence-based results with children from diverse lower income communities, these family and broader community influences do not appear to be impeding significant short-term impact. Nevertheless, additional impact may be achievable by taking these influences into account more intentionally (Elias, Zins, & Weissberg, 1997; McLaren, 2007; Rubinstein, 1994; Sleeter, 1996).

OTU could do more to explicitly include parents. If parents' nutrition and exercise knowledge and behavior improve, health statistics show that children will be less likely to become obese, as discussed earlier. In response to school administrators' desires to include parents more, in 2012 Operation Tone-Up added an explicitly parent-oriented element to its in-school programs (Tony Lamka, personal communication, May 13, 2013; Lamka, 2008-2013). In particular, a new workbook was developed that is more structured and explains in greater detail what is expected and the results that can be accomplished, with the goal of helping parents more (Tony Lamka, personal communications, May 13, 2013). Given the correlation between obese parents and obese children, and CO interventions' focus on lower-income communities and schools with higher than average overweight and obesity rates,

some children's parents may be too heavy and out of shape to safely do the OTU exercise sets for children. On the other hand, Accept The Challenge states that parents can greatly benefit from performing the OTU exercises, which has been witnessed in various OTU studies with overweight/obese teachers who participated in the program (Tony Lamka, personal communications, 2013). Accept The Challenge has declared that it is interested in doing much more to explicitly include parents, if resources are available to do so (Tony Lamka, personal communications, 2013). From an adult development point of view, parents may need their own exercises and/or pace, though with the rigor which has helped OTU to drive significant outcomes. Also, from a curriculum theory perspective, this additional parental learning provides another articulation, this time into parental education and behavior change, which could help to support the sustainability of the child's healthier behavior at the end of the intervention.

While the duration is shorter than other effective programs, the outcomes are impressive. Extending the program's scope in terms of duration, or at least following it up during the remainder of the school year, seems likely to maximize the total impact of the intervention.

Cost is one issue, which as mentioned earlier, is too often ignored in intervention evaluations. If an intervention is highly effective but its implementation costs per student are high, it cannot be rolled out broadly, especially to the lower income schools where CO prevention is most needed, given school districts' dependence on local funding. Operation Tone-Up's structure, with heavy emphasis on DVD-based interactive media, and the potential to become a totally electronic "digital" program, has very low incremental costs. While Accept the Challenge has typically charged $20-30 per student in the past, at high

volumes in roll-outs to hundreds of thousands of schools, the per student fee could potentially fall to below $10 per student. ATC has invested substantial funds in its materials including interactive media over the years, and these costs do need to be recouped (Tony Lamka, personal communication, May 13, 2013). But the low incremental cost per student is the key cost-driver for high-volume implementation, and can keep a broad roll-out very low cost, yet with high impact.

Conclusion

It is not yet clear, if there is a particular CO prevention intervention, which is optimal for schools (van Sluijs et al., 2011). Haynos and O'Donohue (2011) reviewed a range of CO-related interventions, and found that there is no single universal solution yet, which is so well-proven that it should be rolled out broadly to the exclusion of other programs. As we have seen, questions remain about theoretical bases, costs, long-term impact, and so forth What are some of the biggest shortcomings of interventions and their evaluations to-date, which are keeping us from finding universal solutions? One key issue, as Trudeau and Shephard (2010) note, is the challenge of sorting out and addressing confounding variables in the highly complex area of obesity. This chapter's literature review uncovered a number of other major limitations to existing scholarship and practice, which must be addressed before specific universal solutions can be defined and broadly agreed upon. Nevertheless, many best practice approaches have been demonstrated, and highly effective interventions can be implemented now, and then further improved over time, as discussed later.

Two of the most problematic issues are addressed in this study. First is the lack of curriculum theory perspectives, which is related to the divergent communities of practice

needed for in-school CO prevention, and the resulting lack of CO intervention access to schools. Second is the lack of evidence of long-term impact.

We have already discussed in this literature review, how curriculum theory can be more consciously and intentionally used to help strengthen the impact of CO prevention learning, while also helping to build greater support among key school decision-makers and influencers for investing more time and effort over many years in nutrition and exercise education. This seems clear from an analysis of existing programs and evaluations, as outlined in this literature review.

So this dissertation research, instead, explores a second critical open issue identified in this literature review: What is the long-term learning impact from existing in-school curriculum-based CO prevention programs? Ultimately, any in-school childhood obesity prevention program must *both* demonstrate that it can change students' behavior over the long-term *and* be welcomed by schools as an ongoing part of the curriculum. In order to do so, CO prevention programs should meet both curriculum theory and health learning psychology theory principles. At the same time, programs must prove that they have a material long-term impact on nutrition and exercise knowledge, attitudes, and behaviors, and therefore on students' health over many years—all at an affordable cost. To be welcomed, health education should also help schools meet their core academic mission, and show schools in a convincing manner how they are doing so.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

Introduction

What evidence, if any, exists for prolonged behavioral change from in-school curriculum-based CO prevention interventions, as observed through the Operation Tone-Up program? This chapter discusses the main hypotheses, research design, and research methods used to study this question. For this dissertation research, data resulting from Operation Tone-Up's multi-year intervention history in elementary schools were used, in order to assess the intervention's long-term impact, years after the program has been delivered. A longitudinal retrospective study compared students now in middle school, who had participated in OTU in elementary school, with their current peers in those same middle schools, who had not participated in OTU in elementary school. These never-participated students are the control, comparison group. Differences were analyzed up to 3-4 years after elementary school, based on surveying former participants now in "downstream" middle schools. The study attempted to account for confounding factors besides Operation Tone-Up, which may have had a material differential impact on nutrition knowledge, attitudes, and behaviors and physical activity attitudes and behaviors of students receiving the intervention.

Research Questions and Hypotheses

The primary research question is, what is the long-term impact of in-school curriculum-based exercise and nutrition programs intended to prevent childhood obesity? This study approached that question in part by evaluating the long-term impact of Operation Tone-Up, as one example of such a program, which is effective short-term, but whose long-term impact has not been researched. I proposed that effective CO programs produce short-

term and long-term improvements in students' knowledge of nutrition and their attitudes and actions regarding food and beverage choices and physical activity, but that the impact of the programs diminishes substantially over time unless the lessons from the program are adequately reinforced. A related question is, how does curriculum theory help us to evaluate the long-term impact of in-school nutrition and exercise interventions? I proposed that curriculum design theory indicates that one-time and intermittent interventions suffer from inherent weaknesses that undermine their potential long-term impact. Such weaknesses include their scope, in terms of inadequate duration; balance, in terms of the time allocated relative to other subjects; continuity, in terms of lack of long-term enhanced repetition of key content and experiences; and deficiencies that stem from inadequate integration and articulation with the rest of school curriculum.

Methods

A variety of methods were used to gather qualitative and quantitative information for the present study, following guidelines for mixed methods research outlined by Tashakkori & Teddlie (1998). Research with students was conducted with a questionnaire containing both quantitatively scored, closed-ended questions and open-ended qualitative questions (Creswell, 2003). (Please see student questionnaire in Appendix B.) Key school personnel were also interviewed (personnel of Phoenix Area School District, personal communications, 2011-2013; Seidman, 1998). Written quotes from students in response to open-ended survey questions and interview comments from school personnel assisted in identifying confounding factors, and provided richer understanding of student attitudes and behaviors. This latter research included some quantitative elements, but was fundamentally a qualitative process. The primary purpose of the research with teachers and other school personnel was to increase

understanding of confounding influences that may have impacted students' nutrition and exercise knowledge, attitudes, and behaviors. (Please see employee interview protocol in Appendix C.)

Research Design

Variables

The primary independent variable (IV) is student participation in Operation Tone-Up. The intervention group consisted of students who participated in Operation Tone-Up, while students who did not participate made up the control group. Student self-reporting was used to determine whether or not students had participated in the Operation Tone-Up intervention. This was the standard intervention participation IV.

Secondary independent variables included the potential influencers age, grade level, ethnicity (including Hispanic/non-Hispanic), sex (boy/girl), and socioeconomic status (SES). SES was determined by self-reported student participation in the National Student Lunch Program (NSLP; obtained from answers to the survey question: "Do you receive free lunches at school?"), supplemented by reviewing residency as indicated by zip code, and the demographics of the student's most recent elementary school and current middle school.

Dependent variables (DV) included the outcomes nutrition knowledge, attitude, and behavior and physical activity attitude and behavior, as measured by responses to survey questions (Pieter, Fröhlich, Emrich, & Stark, 2010). For example, questions ranged from, "What does protein do for your body that other nutrients can't?" (component of Nutrition Knowledge) to "At recess, how much do you usually run around?" (PA Behavior).

In addition to these variables, a "three-tier" alternative intervention participation IV was created to differentiate between students currently in the intervention, compared to those

who had been in the intervention in the past but were no longer participating in it. In this case of the three-tier intervention IV, I made an attempt to categorize students as either control or intervention students, even when they said that they "don't know" whether they participated, based on the student's other survey responses. If the student indicated, "I don't know," other response data were examined to verify whether the student was likely to have participated or not, rather than simply excluding the case. For example, the student's self-reported attendance at a particular elementary school(s) was compared to information from Operation Tone-Up and from the school, as to whether the intervention was actually offered at the time when the student said that s/he attended the elementary school. Using this approach, it was possible to allocate most "I don't know" responses to either the Yes/Participated or No/Did Not Participate groups, enabling correct assignment to the intervention or control group, respectively. As a result, a higher sample size (*n*) was attained for the three-tier intervention variable.

As discussed earlier, some sub-groups were analyzed statistically by ethnicity, gender, and by socioeconomic status based on National Student Lunch Program participation, to see if controlling for ethnicity, gender and SE helps elucidate differences between OTU participants and nonparticipants. The study assumed that other out-of-school influencers, such as parental and family factors not captured with survey independent variables such as Hispanic ethnicity, sex, and SES, may have influenced results. Nevertheless, the hypothesized associations have been shown.

Other Controls

Since students' nutrition and exercise knowledge, attitudes, and behaviors have been influenced by many factors besides Operation Tone-Up, interviews with school personnel, particularly principals and teachers, were used to help control for other school-based influences besides Operation Tone-Up. The principal approach was to identify and rate other school-based influencers as either major or minor, and to try to estimate their relative influence on students compared to Operation Tone-Up. These interview results were used for a more general, qualitative review of possible confounding influences in addition to the primary independent variables in the survey.

Sample Overview

The sample studied included current sixth, seventh, and eighth-grade students, who had participated in Operation Tone-Up in elementary school (typically during grades 3-5 and in some cases grade 6), and their current peers in their same middle school grades, who had not participated in OTU.

Completed surveys were received from a total of 635 students: 232 students at Middle School A, 375 students at Middle School B, and 28 sixth-grade students at Elementary School A. An active consent process was used, as required by school district research policy. Of 635 student surveys, 370 (58.3%) were matched to parent-approved survey consent forms, resulting in a substantial number of usable surveys for analysis. Demographic proportions were calculated using valid percentage of sample, and therefore excluding missing data and "I don't know" responses.

The sample included 85 students (23%) from Grade 6, 150 students from Grade 7 (41%), and 131 students from Grade 8 (36%). (See Table 1 for comparison of intervention

students to students in the control group, but excluding students who did not know whether they had participated in the intervention.) Twenty-five (25) students (7%) were age 11, 93 students (25%) were age 12, 134 students (37%) were age 13, 105 students (29%) were age 14, and 8 students (2%) were age 15. (See Table 2 for comparison of control and intervention subgroups.) Data from 198 girls (55%) and from 163 boys (45%) were included in the analyses. (See Table 3 for comparisons of control and intervention subgroups.)

Both middle schools and the elementary school sixth-grade class where surveys were conducted include a large percentage of lower socioeconomic, ethnically diverse students. Among students who responded either Yes or No to the question about whether s/he received a free lunch, 200 students (66%) responded that they received a free lunch, while 103 (34%) said they did not. 53 students (14%) said they did not know whether they received a free lunch, and were not included in these valid sample percentages, and the remainder did not respond and were classified as missing data. This response on free lunch was used to determine low compared to higher socioeconomic status. See Appendix A for more detailed demographic data.

The student body for the school district as a whole was approximately 50% Hispanic, 5-10% African American, 5% Native American, less than 5% Asian American, and about 40% non-Hispanic White (School District, 2013). (Exact percentages are not provided in order to help protect the District's confidentiality, as requested.) For my sample, valid self-reported ethnic make-up was 65% White (including Hispanic), 13% African American, 12% Native American, 5% Asian American, and 4% other; however, 40% of students did not list ethnicity (except for Hispanic/non-Hispanic). Fifty-one percent (51%) of students (n=176)

who responded described themselves as Hispanic. Seven percent [7%] of students (n = 24) surveyed did not respond to the Hispanic/non-Hispanic demographic question.

Participation in Operation Tone-Up

Almost one-third of the students sampled (n = 119; 32%) reported having participated in Operation Tone-Up, while 187 (51%) said they had not participated. 61 (17%) said they did not know if they had participated, while 3 (1%) did not respond at all. In terms of valid percent of the sample, 39% said that they had participated, while 61% said they had not participated. Based on reviewing students' other self-reported information, I estimated that 132 (36%) of the sample had participated in OTU, while 238 (64%) had not participated, that is, the vast majority of "I don't knows" had not participated.) See Appendix A for more detailed data.

The below Tables 1-3 provide a breakdown of sample demographics by students in control compared to intervention groups, and exclude "I don't know" responses and missing data.

Table 1

Grade of Students Surveyed

Parameter			
Grade	6	7	8
		n (#)	
Control	18	84	81
Intervention	60	28	31
		n (%)	
Control	9.8%	45.7%	44.0%
Intervention	50.4%	23.5%	26.1%

Table 2

Age of Students Surveyed

Parameter					
Years of Age	11	12	13	14	Other
			n (#)		
Control	3	28	76	71	8
Intervention	18	49	27	23	1
			n (%)		
Control	1.6%	15.1%	40.9%	38.2%	4.2%
Intervention	15.3%	41.5%	22.9%	19.5%	.8%

Table 3

Sex, SES & Hispanic Ethnicity of Students Surveyed

Parameter	Sex		SES		(Non-)Hispanic	
	Boy	Girl	Lower	Higher	Hispanic	Non-Hispanic
			n (#)			
Control	91	92	91	60	70	100
Intervention	46	69	75	28	67	49
			n (%)			
Control	49.7%	50.3%	60.3%	39.7%	41.2%	58.8%
Intervention	40.0%	60.0%	72.8%	27.2%	57.8%	42.2%

Notes for Tables 1-3: Table sample demographics are numbers and valid percentages of total survey sample; control and intervention data exclude "I don't know" responses and missing data.

The control and intervention population demographics were similar in certain respects, with the biggest differences relating to age and grade level. Students in the intervention group were more likely than students in the control group to have lower SES, be younger, in lower grades, and Hispanic. This was understandable, given that the intervention was targeted at these demographic segments, which have a higher prevalence of childhood obesity. One of the middle schools surveyed drew from a somewhat higher SES, more White, and less Hispanic demographic catchment area than the other, with a resulting smaller percentage of students in the intervention group.

Also, one of the three sixth-grade classes surveyed, the one at Elementary School A, was still participating in Operation Tone-Up. Partly as a result, a higher percentage of intervention students were younger and in sixth-grade. This sixth-grade class also provided the opportunity to include data from students still participating in the intervention. The three-tier intervention variable mentioned earlier helped to address these differences.

The higher SES and non-Hispanic proportion among control students provided a certain counterweight to help balance their older, more "adolescent" demographic profile compared to intervention students, since older students in higher grades tend to have less healthy nutrition and exercise, even when they are from higher SES and non-Hispanic families. At any rate, the regression analysis controlled for these differences.

Other Sample Characteristics

The sixth-grade sample was smaller than for seventh and eighth-grade students, and drawn from only three classes, one at an elementary school where the intervention was still being offered, and two others from Middle School A, where the intervention was not offered. The sixth-grade teachers taught one group of students each. In contrast, seventh and eighth

graders were taught by five PE teachers, each with 4-5 different groups of students from 4-5 different class time periods of the day.

The classes in which I conducted research were not strictly randomly assigned, but systematic bias was reduced since students had been randomly assigned to those classes by the middle school administration, without regard to students' participation in Operation Tone-Up or their previously attended elementary school. The classes selected for the current study depended in part on the willingness of the school principal and teacher to participate, as well as the ability to conduct research at a convenient time. Given a typical class size of 25-35, surveys were administered in 27 class sections to reach a sufficient sample size, though seventh and eighth grade sections at the same middle school during the same time period were surveyed together. Access was available to the majority of students at one middle school, and nearly half of the students at the other middle school. There is no reason to believe that these students were materially different than other students at those schools, or that the students in the intervention and control groups, respectively, were materially different from each other, except primarily for the independent variables. Although it is possible that students who were not permitted by parents to participate in the study had different characteristics than students whose parents consented to the study, no obvious bias was evident. Furthermore, teachers reported that they did not observe any particular pattern for parents giving or withholding consent for their students to participate in the study.

Middle school students may have attended one of approximately 10 public elementary schools within the school district which normally feed to those middle schools, as well as public charter or parochial/private schools, or any number of schools elsewhere in the district or outside it. Four of the elementary schools feeding into the two middle schools

where students were surveyed had offered Operation Tone-Up during at least one year within the 5-year window prior to this study. This provided the opportunity to access a major percentage of all students in the area who had participated in Operation Tone-Up within the last 6 years. For example, six public elementary schools feed into Middle School A, but only two of those schools offered Operation Tone-Up, and one of these stopped offering OTU several years ago. Four public elementary schools feed into Middle School B, but only one, Elementary School A, has offered Operation Tone-Up, and it has only done so for the past 3 years. Control groups were somewhat bigger than OTU participant groups in most classes and at both middle schools, but there were a substantial number and percentage of former OTU participants at each middle school.

In addition, students surveyed would normally have participated in Operation Tone-Up for 1, 2, or 3 years (Grades 3-5, or 4-6 at Elementary School A), and may not have participated since 4 or more years ago. (While Elementary School A has offered OTU in Grades 3-6, it has only been offering the program since 2009-2010.) The sixth-grade at Elementary School A participated in OTU this year, using some of the nutrition materials and 10-minute exercise "bursts," not the entire OTU program, according to the teacher (personnel of Phoenix Area School District, personal communications, 2011-2013). Nevertheless, these students were classified as currently participating for the three-tier intervention independent variable. In most cases, students in the intervention group who were surveyed would not have participated since their last elementary school year (2010-2011), or earlier.

The years since participation and number of years of participation are self-reported by students on the survey questionnaire. Self-reported information was checked against a list of schools, provided by Operation Tone-Up, and corroborated in many cases by school

personnel. Using this information, it was possible to make a reliable estimate of the school year(s), in which OTU had been implemented at each intervention school in the area. Since interventions in almost all cases take place during the Fall semester, and the survey was administered late in the Spring semester, participation was classified in half-year increments, (e.g., for current participants 0.5 years ago, for past participants 1.5, 2.5, and so forth years ago). So, for example, if intervention students are in seventh grade at Middle School A, which starts receiving students in sixth-grade, in most cases they would have last participated 2½ years ago in fifth grade; if they are in eighth grade, they would have last participated 3½ years previously in fifth grade. There may also be cases of students who moved between elementary schools, and may have missed participation in certain years, or students who repeated or skipped grades. The number and percentage of such students appeared to be small enough, that no attempt was made to calculate or adjust for them.

The survey captures this information, by asking students the names of the schools they attended in the past and whether they remembered participating in Operation Tone-Up in particular grades. When the sample sizes of these subgroups by years-since-participation and number-of-years-of-participation were large enough, it was possible to make some valuable judgments about the relative impact of certain lengths of participation, and gaps since last participation. These data were summarized in the form of boxplots. Boxplots assist in visualizing results about the long-term impact of Operation Tone-Up from regression analysis. In particular, these boxplots assisted in clarifying trends for the long-term impact of the intervention.

Inclusion and Exclusion Criteria

All students in a particular classroom were surveyed, who chose to participate at the time of the survey. The student's name on the survey was then compared to parents' returned informed consent (IC) forms, in which the parent allowed the use of survey results for research. Each survey that was matched to an affirmative consent form was included in the research analysis unless the student did not give consent. No students formally refused to give consent, but some did not participate in completing questionnaires.

Selected school personnel were interviewed, typically third- through eighth-grade teachers, who had worked at their school long enough to be able to describe possible school-based confounding influencers during the period since Operation Tone-Up started in the school district. For control elementary schools, where I had not met teachers through the survey process, the school principal was asked to identify teachers who were able to discuss nutrition and physical education in the school over the past 6 years. At the middle schools, selected teachers participating in the survey process were interviewed. The interviews focused particularly on the last 6 years, which would have had the most direct impact on students currently in grades 6-8.

Data from students whose parents did not return affirmative consent forms, and students in classes where research was not conducted were excluded. At Elementary School A and Middle School A, I conducted surveys and interviewed teachers in classes, based on principals' referrals of teachers who, among other factors considered by the principal, were judged likely to be willing and able to help effectively in organizing the return of consent forms and completing the surveys. At the second middle school (Middle School B), I

surveyed all students who attended PE classes. Other students and teachers at the surveyed schools were excluded.

At the elementary school, where the intervention was still being offered, a class of one of the three sixth-grade teachers was surveyed, following a referral by the principal. The principal noted that this teacher was an advocate of healthy nutrition and physical activity, so this should be considered when factoring in potential sampling bias. At Middle School A, two of the five sixth-grade teachers were surveyed, based on a referral by the principal. In addition, all PE classes of two out of the four PE teachers at that school were surveyed, except a special needs class, based on a referral by the principal. At the other middle school, all classes of all PE teachers were surveyed, which only excluded the approximately half of band, choir, and orchestra participants who were not required to attend PE during the semester when research was conducted (personnel of Phoenix Area School District, personal communications, 2011-2013).

Sampling Bias

It was assumed that the above sampling process did not materially bias results, because students had been randomly assigned to those classes, and because those classes included approximately one-third to one-half of all students in that grade at the elementary and first middle school and almost all students at Middle School B.

The participation of the majority of middle school PE teachers and therefore of the majority of students, plus the randomness of whether a certain student was in one of those classes, should minimize systematic bias. I did not perceive any reason why one PE teacher's classes would be materially different than another, in terms of its student composition and the pattern of responses to questionnaires. On the other hand, since only a

minority of sixth-grade classes were surveyed, and those teachers were selected by the principals, there is likely to be somewhat more bias than if all sixth-grade students had been surveyed, or a totally random selection process had been used.

While a class size of 20-35 does introduce some basis for sampling error for a particular grade level at a particular school, when aggregated across multiple classes for an entire grade level and across schools as well, these issues should be reduced considerably. HLM mixed models analyses were conducted, in order to determine if there were any random effects.

Data Collection

Student Survey Questionnaire

The student survey, a copy of which is included in Appendix B, consists of instructions, both on the questionnaire and with key points reinforced orally in the classroom during survey administration; self-reported student identification and demographic information, including which elementary schools the student attended and whether he or she participated in Operation Tone-Up; questions specifically based on nutrition content covered during the Operation Tone-Up intervention; and questions asking students to self-report their personal nutrition knowledge, attitudes, and behaviors and physical activity attitudes and behaviors. There are also two questions asking students to report how they perceive the importance of nutrition and physical activity, and how their own nutrition and physical activity impact how well they do academically in class in their school.

Most questions either offer a categorical choice between two distinct alternatives or use a 3- to 5-point choice, Likert-based approach, in which students choose the most accurate among distinct alternative answers on a continuum. However, in order to maximize student

comprehension, instead of choosing a number scale answer, such as 1-5, a range of verbal answers or quantitative ranges was provided, amongst which students were asked to choose. These were converted to numeric categorical, nominal, or continuous scales, as appropriate, for data processing.

"I don't know" was offered to students as a possible response in a number of cases; this allowed me to know more clearly if students did not know an answer, rather than forcing them to guess among affirmative choices. Nevertheless, many students tried to answer the question anyway, instead of choosing "I don't know," even when their other responses suggested that they did not have a sense of the correct answer. For example, students who did not get any of the Nutrition Knowledge questions right, often selected the wrong answer rather than "I don't know." This may have been because students were conditioned through normal test-taking to try to answer questions in order to optimize their score, in case they happened to guess the right answer.

There were also several open-ended questions, allowing students to provide qualitative answers in whatever manner they wished. These qualitative responses were reviewed with a particular focus on differences between boys and girls, given the powerful association of gender with a range of dependent variables in this study. This permitted deeper understanding of the significant differences between boys' and girls' nutrition and physical activity knowledge, attitudes, and behaviors, and between control and intervention girls, which the quantitative data had indicated. Differences between boys and girls in control and intervention groups were further compared by grade of respondents.

I did not know whether a significant percentage of students had repeated grades or skipped grades. So it was not possible to code responses in order to avoid under or

overestimating the number of years participated in OTU, the gap since the student last participated, and so forth. Information regarding students who skipped or repeated grades was not available, raising the possibility that students' grade levels may over or underestimate the length of time the student participated in OTU and the time that elapsed between OTU participation and the survey. Only questionnaires completed by students whose parents had given affirmative consent on their signed consent forms were included in the research database. In addition, parents or students could choose to withdraw responses submitted previously.

Student Cardiovascular Measurements

A physiological measurement of resting heart rate was made, but limitations of the measurement process led to a decision not to use it in the study. The student's resting heart rate was measured at the elementary school and the first middle school. This would have ideally helped to normalize comparisons between students, as well as to generate objective data for comparison.

I measured resting heart rate with an automated, electronic finger monitor. (An integrated, automated, inexpensive blood pressure [BP] and heart rate monitor which is attached around the wrist had also been tested, but it was felt to be deficient. For example, one overweight student complained that the automatic BP device pump constricted his arm too much and hurt.) The heart rate device used measures resting heart rate in less than one minute, displaying it digitally on a small monitor screen on the finger. Five to 10 of these devices were used at one time, in order to minimize total class time devoted to research. After giving instructions to the students in the class on how to use the monitors, I gave the devices to the students, in some cases assisted by teachers. Students were instructed to sit

quietly, thereby calming their cardiovascular systems for several minutes, while completing their questionnaires. After completing their questionnaire, the students then measured their own heart rate, and noted the results on their questionnaire.

I had instructed students to write down the lowest heart rate that they detected. However, I noticed during implementation that some of the monitors very briefly displayed a very low heart rate for a split second for some students, before stabilizing at the correct heart rate. Also, the volume of students plus the limited amount of time available made double-checking not feasible in many cases. Since students had been instructed to write down the lowest heart rate observed on their finger monitor, some students may have recorded an artificially low heart rate. I believe that this aspect of self-reporting, in which students measured their own heart rate, was the weakest part of the research implementation. While I had hoped for a quick, simple, inexpensive, yet reliable means to obtain objective physiological data, this approach did not turn out to be reliable. As a result, I regarded the heart rate data as of questionable validity, and did not use it in the analysis.

School Personnel Interview Protocol

Interviews with school personnel were conducted, primarily to identify other factors which may have influenced students' nutrition and physical activity knowledge, attitudes, and behaviors, besides Operation Tone-Up and the main grade and demographic independent variables. Interviewees were given a brief description of the research and why it was being conducted, and were asked to review and approve a consent form. They were then asked questions about what had been done at their school over the last 3-6 years to improve nutrition and exercise knowledge, attitudes, and behaviors. Interviewees were also asked

about practices at the school to improve food and drink provided to students and to increase physical activity.

The primary focus was on school-based influences, but interviewees were also asked about non-school factors, which they believed impacted students' nutrition and physical activity learning. Finally, if there was time remaining in the interview, there were some open-ended questions asking about a range of related matters (Calderwood, 2003). Several teachers who had implemented Operation Tone-Up were in certain cases asked to use percentages to quantitatively rate the relative importance of these other factors, in contrast to Operation Tone-Up, as well as to give open-ended qualitative answers. A copy of the interview question protocol is provided in Appendix C.

Validity

I attempted to find validated instruments that covered the topics in the survey. At present, there are no validated instruments that collect the information needed for the present study which have sufficient face validity for the purposes of this study and could be administered within the expected time limitations. Instead, I developed a survey questionnaire with question formats and approaches based on established instruments wherever feasible. Feedback received from experienced researchers on specific questions and answers in draft versions of the questionnaire was incorporated into the final version. My survey drew upon other established surveys including Active Where? (Active Where? Project, 2004-2005), PACE+ (J. J. Prochaska, Sallis, & Long, 2001), CATCH (Sallis, 1993; University of Texas-Houston Health Science Center, 1999), and SPARK (Project SPARK, 1991; Sallis, 2012, 2013). The pilot process further assisted in improving questions.

Several approaches were used to determine the status of each student's participation in Operation Tone-Up. First, the student was explicitly asked whether s/he participated in OTU in the past. Second, the survey asked which elementary schools the student attended in each grade; these data could be compared to records from Accept The Challenge which documented the schools that had implemented OTU programs and the years of participation. Thirdly, students in the intervention group were asked the name of their elementary school teachers, which could be compared to known information, though these latter responses were used more for background, and were not judged necessary to verify intervention participation. Finally, students were asked a simple question about whether Operation Tone-Up uses cartoon characters (a key element of the OTU program that should be particularly memorable), as a further check on whether they participated, though this information was not used in the analysis. By triangulating between these student responses, it was possible to reach conclusions about the student's actual participation in OTU beyond the student's explicit response on past participation. This process was helpful in classifying students who had said that they "don't know" if they participated into either the intervention or control group. Several revised participation-related variables were created for this, to supplement the variables which are exactly as self-reported by students, as described earlier.

The initial set of survey questions on nutrition knowledge were based on nutrition material specifically covered in Operation Tone-Up. For questions which ask for self-reports on nutritional attitudes and behaviors, jargon was avoided and questions were asked in a way that students could understand. For example, the student questionnaire does not ask about the number of servings, which is a USDA and Nutrition Facts category which many people

find difficult to understand or to relate to their personal practices. Open-ended qualitative questions provided another perspective besides the pre-determined response choices.

Regarding the validity of school employee interviews, the interactive nature of the interviews and the chance to delve into the main alternative nutrition and PA influences helped to improve validity.

Reliability

A pilot study was conducted with a sixth-grade class to help ensure that students understood the survey questions and the answer choices, which enhanced reliability. Also, the responses to open-ended question helped to verify reliability. A re-test was also conducted with an improved but similar version of the instrument with the same sixth-grade class a few weeks later, before the main research period, in order to improve the survey questionnaire as well as to check its reliability.

Nevertheless, reliability should be a limited issue with this study, since the study is more concerned with comparing relative responses between groups than making objective judgments about the absolute generalizable accuracy of particular answers. The main goal with the student survey questionnaire was not to develop absolute quantification of students' nutrition and exercise knowledge, attitudes, and behaviors, but to find relative differences between the former Operation Tone-Up participants compared to the control group of nonparticipants. Consequently, it can be argued that reliability in this study is less important than in some other circumstances. If some questions and/or answers were misunderstood, it was assumed that misunderstandings, if any, should be relatively equally distributed between participants and nonparticipants on all questions which were not drawn directly from the

Operation Tone-Up program materials. Only questions 1-5 related to nutrition knowledge are drawn directly from Operation Tone-Up.

An electronic monitor which had received highly rated reviews on Amazon.com by large numbers of home users was selected to measure resting heart rate. Many users said that the measurements were comparable to ones they received by nurses using traditional medical heart rate measurement equipment. Nevertheless, since the heart rate measurement was made by the students themselves, even though the monitors are simple and instructions were given which appeared to be understood by students, there was substantial variability and inconsistency in measurements, significantly reducing the validity and reliability of heart rate data, as described earlier. For example, some monitors very briefly gave an inaccurate reading when starting up, apparently a "bug"/defect of the booting-up process, which had not been noticed during the pilot process. As a result, these physiological data were not used in the data analysis.

Regarding the reliability of school personnel interviews, the interactive oral format allowed clarification of questions and answers, repeating questions when requested, and so forth, in order to ensure that school employees understood questions and had communicated answers accurately.

Cost

The student questionnaire was printed on one sheet of double-sided, 8½" x 11" plain paper, making the instrument itself very inexpensive. The heart rate monitors cost about $40 each, plus several dollars for spare batteries, and were shared by multiple students during a given classroom period and re-used among classes. Coding and data entry were relatively

straightforward and inexpensive, costing about $500. Statistical analysis was more expensive, costing several thousand dollars for third-party assistance. Donations to schools and teachers, in order to encourage participation and to compensate for the time involved, as discussed later, also cost several thousand dollars.

Trustworthiness, Authenticity, Credibility

The survey questionnaire was shared at different points in the research process with selected principals and teachers to solicit feedback and obtain a check on validity of the results. Students' questions as well as survey responses to the initial draft questionnaire during the first stage of the pilot were used to improve the questionnaire for the second stage of the pilot. Students' responses to that second pilot version were then used to improve the final questionnaire. In addition, summary results of the final research will be shared with school personnel, since many expressed interest in the outcomes. If time allows, results may also be shared with students.

Coding

A coding system was developed for the quantitative data, with initial outlining in Excel for final implementation in SPSS, in conjunction with a data input research assistant. I decided not to code open-ended, qualitative question responses for inclusion in a quantitative database. Nevertheless, I did review comments separately by gender, grade level, and intervention participation, in particular, in order to better understand major PA differences by gender and grade in the outcomes. Certain students' quotes were also used anecdotally to help illustrate common perspectives.

Pilot Study

My principal goals during the pilot were to test and improve the student questionnaire in order to maximize validity with middle-school age students. I also wished to become proficient at using the blood pressure/heart rate monitors efficiently, in order to minimize class time used and maximize reliability of measurements. I also wished to begin understanding the school environment, communicating with teachers, and revising the school personnel interview protocol with school personnel.

The principal of the elementary school, Elementary School A, where the pilot study was conducted, had implemented Operation Tone-Up for several years, and still used it or components of it at her school. She offered to have research be conducted at her school, including the pilot study among sixth-grade students. I conducted research with one class of sixth-grade students for the pilot study. The principal reported that there is a 28% student turnover at her school, so some students in the sixth-grade class had not been at the school or participated in OTU the year before. At the time of the survey, the sixth-grade students were using the Operation Tone-Up CD for regular exercise, but were not participating in the standard OTU intervention. Indeed, it should be noted that, during the school year when the survey was conducted, intervention exercise had been conducted at this school in 10-minute "bursts," which is not per past OTU standards. In addition, the nutrition-related elements of the intervention workbook may not have been implemented per OTU standards. Newly enrolled sixth-graders at Elementary School A who had not participated in OTU in earlier grades may not, for example, have had the OTU nutrition education in a comprehensive manner, and may not have had the OTU explanation of the importance of nutrition and exercise, even though they had been doing some OTU-related exercises. As a result, their

exercise attitudes or behaviors may be similar to former OTU participants, but other aspects of their knowledge, attitudes, and behaviors, particularly in regard to nutrition, may have been different.

Nevertheless, sixth-grade students from Elementary School A in the pilot study and in the final data were in a class which, according to the teacher, used both the OTU exercise DVD/CD and "partially used" the workbook in 2011-12. The degree of participation was judged substantial enough to consider them as participants in the intervention group. In addition, the target age and developmental and education stage of this sixth-grade group were appropriate for preparing for research with middle school students, some of whom were in sixth-grade and of a similar age or older. These factors are important in testing survey questionnaire instrument validity and reliability, as well as reactions to and challenges in using blood pressure and heart rate monitors. If I had felt the need to extend the pilot to students at middle schools in the same school district that did not have elementary school students on their campuses, I would have done so. Once appropriate research permission was received from the School District, and related permission from Fielding Graduate University IRB, I subsequently conducted research at two of the middle schools during the full study after the pilot.

Settings

I surveyed one teacher and sixth-grade class at Elementary School A for the pilot and full study. In addition, I surveyed students and interviewed some personnel at two middle schools, as described earlier. The vast majority of students at these middle schools participated in PE. All schools were located in Maricopa County, Arizona, and had substantial low SE and Hispanic populations.

After completing all required forms, the School District approved the Request to Do Research, with an agreed data collection schedule for the survey questionnaire and heart rate measurement-taking process during the first 2 weeks of May 2012. A sample permission letter for the principal is attached in Appendix F. I met with the middle school teachers ahead of time in order to explain the research goals and process. I then surveyed students in classrooms in the presence of their teachers.

I interviewed school personnel at the elementary schools which feed the most students into these middle schools, some of which had implemented Operation Tone-Up over the last 3-10 years, as well as interviewing teachers at the middle schools. Teachers and other personnel were interviewed either in-person at school at a time convenient to them, or on the telephone at a convenient time, generally using the interview form in Appendix C. Most interviews were conducted in April, May, and June, 2012.

Procedures, Consent, and Research Ethics

Access to Participants

I identified the grades and schools most likely to have former participants in Operation Tone-Up in their classrooms, while also having a large number of peer students who had never participated in OTU, for control purposes. I then worked with school administrators and teachers to access classes at the most convenient time for teachers. For school personnel interviews, I talked with principals and other school personnel for referrals to teachers and other relevant staff. The informed consent process provided a good means to ensure voluntary participation, as described above. IC samples are in Appendices D and E.

After receiving School District Board approval, I offered donations to schools which participated in this study, in recognition of their participation. I also checked with school principals to see if incentives for teachers, specifically for help in having parents and students return consent forms, were likely to be necessary. Since the School District had mandated an active consent process requiring affirmative parental consent, and since the middle school principals were concerned about possible low survey return rates, I decided to proceed with incentives. These are described in more detail below.

While I attempted to keep the time investment of administrators, teachers, and students low, the research process did take some time and effort by school personnel, and reduced classroom time by 20-40 minutes during administration of the survey. For the sixth-grade only classes, there were only 25-35 students per class, while for the middle school classes, 2-3 PE teachers' classes were surveyed together, typically totaling 50-100 students at a time. I worked with the teachers, who were always present, to maintain discipline, while I explained the surveying procedure and questionnaires and pencils or pens were distributed to students. In the case of the combined middle school classes in the gym, teachers were requested to assist in maintaining adequate spacing between students, in order to minimize peers influencing each other's responses. Students were specifically requested orally and in survey instructions to answer honestly, and I explained that honesty was the most helpful approach to help improve students' health through the research. Nevertheless, social desirability bias may lead to some biased responses, as some students over or understated their self-reported attitudes or behaviors, in order to conform to peer, parent, teacher, or other social expectations (Neuman, 1991/2006), as discussed further below.

Donations were allocated for teachers to use in classrooms where research was conducted, and for use in the classrooms by teachers interviewed, with some money left over for the school as a whole for allocation by the principal. A higher donation was given to teachers based on the percentage of parent permission slips turned in, whether consent was given or not, as modeled by other school researchers (Secor-Turner, Sieving, Widome, Plowman, & Berk, 2010). The donation allocation by classroom was based on the percentage of students returning completed consent forms, whether giving permission or not.

For the highest-return class period for each teacher, the donation was up to $100 for 100% of consent forms returned. For example, if 80% of students returned permission slips in the class period with the highest return rate, then $80 was to be allocated to that classroom. For teachers who had multiple classes, such as PE, or the pilot research session followed later by the standard research session for the same classroom, as at Elementary School A, the follow-on sessions were calculated at half of the first session rate. For example, if the second classroom period had 70% of consent forms returned, the donation was $35. I originally planned to make a donation only for class sections where the rate of return of permission slips was 50% or more, but I eliminated this minimum so that teachers received a donation for all class sessions, even if the return rate was less than 50%. Again, donations were given simply for returning a completed consent form, whether consent was given or not, in order to prevent parents or students from feeling pressure to consent.

Also, donations were combined for the PE teachers at each middle school, at their request, since they wished to pool their donations to purchase equipment and other items as a group for their students. Donations per teacher who participated in the survey research ranged from $75 to almost $200 at the middle schools. Associated donations were made to

the principal for the school as a whole, at the principal's discretion, for close to $600 for each middle school. In retrospect, the donation for the school as a whole was probably twice as high as needed, but it was consistent with the formula that had been mentioned to school personnel.

I also donated $50 to each teacher interviewed who had not also participated in the survey research, and donated $50 to the principal of that interview-only school for use at the school as a whole, at the principal's discretion, in general recognition and appreciation for the introduction to the teacher.

Donations were all delivered indirectly through the central School District administration to the schools' principals for distribution, at the School District's request. However, principals and teachers were notified of the amount of the donations for accountability.

One movie ticket was also given to each student who returned a consent form signed by one of their parents, as Secor-Turner et al. (2010) and others had successfully done. Students received a movie pass, either directly from me or from their teacher, in exchange for a returned, completed consent form, whether consent was given or not.

These various financial incentives all seemed to help increase the return of consent forms and participation in the surveys.

Protection of Participants/IRB

Informed consent was required from parents, as described above. A sample form is attached in Appendix D. Student survey questions and health-related measurements were restricted to "minimal risk" data requests, with none having materially above-normal stress potential. No research was conducted on controversial topics such as sexual practices or

substance abuse. The research process seemed more likely to, if anything, raise students' consciousness of health including nutrition and exercise, as opposed to creating anxiety or embarrassment. Since some children may have a parent who is an undocumented immigrant, no information on schools previously attended outside the USA was requested. In addition, surveys were completed by students on individual survey forms that they completed on their own, and were not shared with anyone except researchers, and were shared only after the surveys had been anonymized to protect students' privacy.

Student were informed that they could choose not to participate in the survey through oral instructions I provided, and in writing on the consent form and the survey form itself. Some teachers asked students whose parents had denied permission on consent forms, to sit apart from the other students taking the survey. A very small number of students chose to either sit separately on their own, or to only partially complete surveys, in such a way that it seemed clear that they did not wish to participate—in which case their partial results were not included in the research database. Survey questionnaires completed by students who did not have parental consent were excluded from entry into the research database. I did not calculate how many students did not provide completed or valid surveys, even though their parents had provided consent. In addition, heart rate was measured individually, and not shared with or visible by others, unless students chose to show it to their peers; also, these metrics are not sensitive ones, since students are unfamiliar with "normal" ranges. In addition, no BMI measurements were taken, which further helped to minimize the chance of embarrassment.

In brief, I designed the choice and wording of the survey questions and the method of collecting health-related measurements to avoid confidentiality and privacy issues and

minimize personal stress. The only personal identifier which could readily be traced to the individual student, the student's name, was replaced with a unique anonymous identifier, before anyone else had access to the data, such as for data input into a database. The original survey and measurement forms were placed in a locked, private location, and used only at that secure location. Names of participants were retained in a secure confidential manner, in case needed for future research-related authentication or verification, or in case a parent or student requested to have the student's data removed from the database, as described below. At the appropriate time, the originals, too, will be destroyed through secure shredding.

Fielding IRB

I completed the Fielding IRB process and received conditional approval, pending minor changes including changing a small amount of wording on some forms, submitting a request to conduct the research to the School District Superintendent, and submitting a request for permission to make donations to schools to the SD governing board. Permissions from the School District were received subsequently. Once I received their response, the revised forms were then submitted to Fielding IRB, along with the District-authorized parental consent form. Fielding IRB was also provided with the email or other documentation from the District, showing that permission had been received from the District to conduct research, and from the District School Board to provide donations to schools participating in the research.

School District IRB

As requested by the School District, a Request to Do Research form was submitted to the District in early March 2012, using the District's form and answering their questions. The same basic responses were submitted as for the Fielding IRB, except on informed consent, since I had discovered that active consent would be required, and that passive consent would not be acceptable to the SD. The principal of Elementary School A had stated that active parental consent was the normal procedure in the district. Parents were required to affirmatively opt-in to an activity requiring parental consent, including research. So instead of using passive consent, as originally planned in order to maximize participation rates and minimize logistical issues, I used the standard District approach to informed consent.

Parental and Personnel Informed Consent

Informed consent was requested from students' parents for their student-children, and from school employees being interviewed, using different IC forms, both of which are attached in Appendices D and E. The parental consent for students was distributed in whatever manner the school wished that was consistent with ethical and legal research practices. The schools chose to have students bring home the IC form to their parent(s). As noted earlier, I had intended to use a passive IC form with parents, since the surveying and measurements involved minimal risk, and since passive consent response rates in student-parent situations of this kind are typically substantially higher than active consent processes with "minimal follow-up" (Secor-Turner et al., 2010), thus improving validity of results. However, since the School District only uses active consent, I modified the parent IC accordingly. I then received SD approval of the Request to Do Research, including the IC

form. Given the high Hispanic population, I had the consent form translated into Spanish for those parents who preferred Spanish.

While an active consent process endangered the research time window at schools, which is highly constrained by the school year, and undoubtedly took more time by school personnel, response rates were relatively high. In the end, completed consent forms were received back from 60% of enrolled students' parents, of which 78% provided affirmative consent for their child to participate. This was lower than Secor-Turner et al.'s (2010), affirmative consent rate of over 90%; however, Secor-Turner et al. received almost one-third of their affirmative consents by directly contacting parents by phone, which required a "substantial commitment" of "25 minutes of research staff time," assumedly per consent form or per student (p. 78). So this study's affirmative consent rate was somewhat below Secor-Turner et al.'s non-telephone affirmative consent rate.

Secor-Turner et al. invested $11 in cash incentives, primarily for the movie theater coupon, apparently, and noted that typical active parent consent campaigns cost $20-25 per student. I spent about $6 per completed consent form for movie theater coupons, plus an average of about $8 in donations to teachers and schools, for each completed consent form. The amount of time I invested was a small fraction of the time spent by Secor-Turner et al., since I worked only through teachers and principals to obtain consent forms. I believe that teachers' time investment was no more than several hours each, and the principals' time was minimal. As a result, this study's affirmative consent return rate of 47% of enrolled students was slightly above the midpoint of the range for research projects with minimal follow-up, for which affirmative response rates typically run from 30-60% of students (Secor-Turner et al., 2010).

As discussed above, part of the donation money was allocated based on consent form return rates, since teachers should have significant influence on response rates, and they can help motivate students to bring in forms. As noted earlier, the teachers' donations and the students' movie passes were based on bringing back a completed consent form, whether it was signed or not, and whether permission was given or not, so that neither school personnel nor parents nor students should have felt pressured to secure or provide consent.

In order to interview school personnel, I used the school personnel informed consent form approved by the Fielding IRB for school employees, who were interviewed. The consent form was provided to school employees prior to the interview, and they were given adequate time to review it. They could then keep a copy, and provide a signed copy or consent by reply email. Donations to schools and their personnel totaling over $3,000 were contingent on School Board approval, and were approved, as described earlier. Please see Appendix E for a copy of the employee IC form.

Processes

I contacted school principals to gain access for student surveys, including providing a request for permission to conduct research, as required (see sample letter in Appendix F, which was typically provided in-person), and I followed any other school district policies needed to gain access. Working with school administrators and teachers, the research purpose and process was explained to school personnel, particularly teachers whose classrooms I wanted to access, typically one week or more in advance of the survey dates.

Where parental consent was denied or not affirmed, a survey form might still be given to the student, so that the student did not feel uncomfortable being excluded, and in

order to minimize potential logistical delays and excess use of classroom time, but in any case the student was told that s/he could return the survey blank.

It was expected that the total in-classroom data collection process would take 10-20 minutes, depending on the size of the class and whether a research assistant was used. In fact, the process typically took 20-30 minutes, and somewhat more with very large class sizes.

I did not plan to use a research assistant (RA), but decided to do so during the data input and analysis phase. The RA was required to sign the RA confidentiality agreement beforehand, and the research study was thoroughly explained to the RA. My statistician also completed the RA agreement.

As for the employee consent form, I gave the employee a copy of the form at the time of the interview, if it was in-person. If a phone interview was more convenient, that was arranged, including providing the informed consent form via email to the employee.

I wrote a thank-you note by email to all teachers who provided access to their class, as well as to school employees interviewed, the school principal, and any other school personnel with significant involvement. (See sample thank you note in Appendix G.) It was expected that the employee interview process would take 15-30 minutes per employee, and this proved about right.

Protecting Confidentiality and Privacy

The survey form includes a heart rate measurement data capture area at the bottom. The process for completing the survey including the integrated physiological measurement form was designed to maximize privacy and confidentiality, as described earlier. The only personal identifier which could readily be traced to the individual student, the student's

name, was replaced with an anonymized identifier, as described earlier. The original survey and measurement forms are in a locked, private location, and will only be preserved as needed, in case the parent changes her/his mind about giving consent, and for future authentication or verification in a secure, confidential manner. Once it is clear that data authentication or verification are no longer needed, for example, after the peer review processes for future journal articles are complete, I will dispose of the originals. Until then, they will be in a locked, private location, such as a safety deposit box at a bank. I will not release the names of the schools or their personnel who participate, per their IRB, unless they specifically request me to do so in writing. The School District has requested that I not mention the names of the school district or schools in this dissertation.

Data Management and Analysis

Access was available to historical summary data on Operation Tone-Up's short-term impact on elementary school students' nutrition knowledge, strength in terms of push-ups and sit-ups, blood pressure, resting heart rate, and more recently BMI. Accept The Challenge (ATC) provided this information in two summary, anonymized reports assembled by a third-party research organization and an actuary, respectively. ATC has also provided other, less comprehensive data on OTU's results. Many of these data are already available publicly through OTU's web site, www.operationtoneup.com. Accept The Challenge's Executive Director, Tony Lamka, who creates and operates Operation Tone-Up, provided permission to use archival data. (See attachment in Appendix H.)

For this dissertation, to a large extent because large amounts of quantitative survey data were available with which to work, I decided to use qualitative responses more

narrowly. The overall thrust of comments from different groups was compared and quotes were used to illustrate key points, rather than coding them and analyzing them in a more comprehensive, quantitative manner. While the qualitative responses appeared to offer some insights, particularly when comparing girls' physical activity between the control and intervention groups, the quantitative survey response data provided a more rigorous and differentiated means of comparing responses. So study data analysis focused primarily on the quantitative survey response statistics rather than the less precise process of classifying, assigning values to, and analyzing the qualitative responses. (In the future, a code could be developed for the open-ended qualitative questions to the extent possible. If this is done, a reliable coder needs to code each qualitative response on the anonymized questionnaires. Two coders should not be needed, because the volume of open-ended answers is limited, so intercoder issues should not exist.)

Data were entered into a SPSS statistical database by a RA under the supervision of a university professor, and both were experienced with research database set-up and inputting. The inputted data were 100% double-checked by the RA. In addition, I spot-checked several individual cases against the original data. The research assistant signed a Confidentiality Agreement, and was provided with only the anonymized student questionnaires.

I also used a statistician, Dr. Maike Rahn, experienced in academic research analysis of the kind researched in this study, to help ensure accurate database set-up and interpretation of the research data. Dr. Rahn worked with The Analysis Factor, a professional statistical training and analysis service, as well as serving as a research associate at Cornell University, where she has worked extensively on nutrition research, as well as physical activity and other areas. Detailed comprehensive analyses were conducted of a wide range of variables, chi

square tests, logistic and linear regression models, and so forth, including reviewing potential interactions, residuals, collinearity and correlations between variables, and other confounding factors. Mixed model/hierarchical linear modeling was also conducted, in order to help detect possible influences related to schools. SPSS version 20 release 20.0.0 and SAS 9.3 statistical software were used.

Introduction to Analysis

The goal of the data analysis was to compare the responses of former Operation Tone-Up participants with those of nonparticipants. Frequencies were computed for all demographic variables. Chi square and t-tests were used to assess whether there is a statistically significant difference between responses of the control and intervention groups and subgroups (Pieter et al., 2010), as described elsewhere in this study. Chi-square analyses were performed to test for associations between intervention conditions and demographic characteristics to determine the principal independent variables.

In addition, preliminary regression analyses were conducted to compare responses from current and former OTU participants and non-participant control students (Muijs, 2011; Ravid, 2011). The number of years during which students participated in OTU was reviewed, as well as how long it had been since students last participated. One goal was to find differences in impact, if any, depending on the duration and proximity in time of students' exposure to OTU. Trends between outcome variables and participation over time were investigated visually by plotting outcome variables against number of years of past participation. In cell sizes with $n < 5$, Fisher's Exact Test ($n = 1$ to 4) was used, or one or two cases were temporarily recoded to address empty cells issues, as appropriate.

Steps were also taken to address potential confounding variables. I worked with my statistician and dissertation committee to model confounding influences as effectively as possible in the quantitative analysis, in order to minimize confounding influences and to maximize validity. Bivariate analysis identified key independent and dependent variables which appeared influential and included a review of the interactions among these variables. These included commonly considered demographic IVs, such as age, grade, socioeconomic, ethnic, and gender differences (Gordis, 2009). Gender and ethnic self-reported data from surveys were used for comparison and analysis.

Socioeconomic status was determined from the student's self-reported data on whether s/he received a free lunch at school, since student eligibility for participation in the National School Lunch Program (NSLP) is dependent on income level. A student's participation in NLSP at the school is a commonly accepted alternative means of assessing relative income level. The apparent demographics of each elementary school were reviewed as a "sanity check," as discussed earlier, and were determined to be aligned with the self-reported "free lunch" data from students. Regression analyses were then used to help determine the relative impact of ethnicity, gender, and income level (Pieter et al., 2010), and relevant interactions, including intervention variables.

It was also necessary to consider differences in student demographics between middle schools. Since these middle schools in the present study draw from 4-6 elementary schools, and are therefore geographically separated from each other much more than are elementary schools, student demographics vary between the middle schools. For example, Middle School A had a higher percentage of lower income and Hispanic students than Middle School

B. It was important to remain mindful of these and other potential issues when analyzing study data.

I attempted to identify and consider the relative impact of confounding variables discovered during interviews with school personnel. In addition to qualitative responses from personnel on possible confounding influences, employees at some schools, which had implemented OTU, were asked to quantify the relative impact of the confounding influences compared to the impact of Operation Tone-Up, as described earlier.

Variables

The following section describes key independent and dependent variables used in the analysis. These include original variables which students selected from among standard response choices to survey questions. They also include variations on student self-reported variables, based on combining students' responses into super-variables, or calculating other new variables, using data from the original variables together with data from other sources such as from Accept The Challenge and school personnel.

Dependent Variables (DV)

Unless noted otherwise, outcomes were measured dichotomously, with a higher number indicating a healthier response in all cases except for the dependent variable, *Low PA Behavior* (that is, low PA at recess), where a lower number was healthier. This accommodated a variety of formats for responses, including many which were already binary. This factor analysis approach is seen as a valid way of assessing related variables (Neuman, 1991/2006, pp. 540-541):

> *Nutrition Knowledge*: Super-variable combining student's responses to three different questions, on the roles of protein, carbohydrates, and metabolism. Consistent with

many other dependent variables in this study, this outcome was measured dichotomously, as either the student getting all answers correct, or not. (Sodium was not included in this DV, as sodium's nutrition role was found to be relatively well-known among respondents.)

Nutrition Attitude: Super-variable combining responses on student's nutrition preferences, both whether s/he preferred water or soda, and whether s/he preferred fruit or a candy bar. This outcome was measured dichotomously, as either the student choosing the healthy alternative for both questions, or choosing one or more unhealthy responses.

Nutrition Behavior: Super-variable, measured continuously, combining responses on self-reported fruit-eating habits and soda vs. water drinking habits, with the higher number healthier. This super-variable consolidates the responses from three nutrition behavior questions into one variable: When was the last time that the student reported eating fruit, how many times per day does the student eat fruit or vegetables, and how many times per day does the student drink soda? Two of the three variables were inverted, in order to have higher scores indicate healthier nutrition behavior for all three variables. The higher the score, the healthier the reported behavior was, up to a total possible score of 12.0, if the student made the healthiest choice for all three questions. In contrast to all other dependent variables analyzed, the range and normal distribution of the variable allowed use of a linear rather than logistic regression. Therefore, nutrition behavior is a continuous dependent variable.

PA Attitude: Original variable, measured dichotomously, indicating whether student prefers at recess to talk with friends, or play a game that involves running with friends.

High PA Behavior: Transformed variable, measured dichotomously, combining students who responded that they ran around either All the Time or Most of the Time at recess, and comparing their responses to all other responses combined.

Low PA Behavior: Transformed variable, measured dichotomously, combining students who responded that they ran around either None or A Little at recess, and comparing those responses to all others combined. (As noted above, this was the only dependent variable, for which a higher outcome indicates a less healthy response.)

Other Dependent Variables: Other potential DVs from the survey are not included in the quantitative analysis. Certain quantitative DVs were judged not to be insightful or not to be as relevant as the above DVs, for a variety of reasons. Nevertheless, some other DVs are discussed elsewhere here, either as qualitative student comments, or in regard to students' perception of the importance of nutrition and PA, and of the impact of nutrition and PA on their academic performance.

Independent Variables (IV)

Potential influences were measured in the most appropriate manner, whether dichotomously or continuously in either a nominal, interval, or scale manner. This accommodated a variety of formats for responses. IVs generally related to student demographics, information on the student's school, and their participation in Operation Tone-Up:

Self-reported by student:

Age: Years of age reported by student at time of survey.

Sex: Boy (1) or girl (0).

FreeLunch ("SES"): Receives free lunch (1) or not (0).

Ethnic_Main: Student's ethnicity (choose from list or describe other).

Hispanic: Hispanic (1) or not (0).

GradeNow ("Grade"): Grade enrolled in at time of survey. (Note that grade not only reflects the student's academic grade level but also the student's relative development stage in adolescence, with its resulting social and psychological impacts on nutrition and PA. This is especially relevant in this study's regression analyses, where age was typically removed as an IV due to correlation with grade.)

SchoolNow: School attending at time of survey.

Tone_Up ("standard intervention IV"): Whether student participated or not in Operation Tone-Up.

Years_OTU: Number of years during which student participated in Operation Tone-Up.

Calculated:

School_Main_Elem: Elementary school, which student attended most (estimated based on student's responses naming the school attended in each year for Grades 3-6).

Tone_Up_Status ("three-tier intervention IV"): Respondents are divided into three groups: Students participating in intervention at time of survey (2 or 2.00); students who participated in the past (1 or 1.00); students who never participated (0 or 0.00).

Utilizes calculated data, regarding if and when the student participated in the intervention, as described below. Also called the three-tier or Status variable.

Years_Since_OTU and related variables: Calculation of how many years it had been, at the time of the survey, since the student had participated in the OTU intervention (0.5 if students participated in the current year, 1.5 if in the prior year, and so forth, since the intervention typically took place in the fall, while the survey took place in May). In one iteration of this variable, as used in the boxplots, control students were assigned 10.0 as a placeholder for purposes of the statistical analysis.

Years_OTU and related variables: Calculation of how many years student participated in intervention.

Other:

A variety of other independent variables were calculated, in order to improve the accuracy and/or sample size (*n*) of self-reported data by students on their participation in Operation Tone-Up. For example, many students reported that they "don't know" whether they participated in Operation Tone-Up, or they reported a particularly high or low number or no number for the number of years during which they participated in Operation Tone-Up. Using their school information, and comparing it to information from Accept The Challenge and school personnel, it was possible to estimate whether the student had indeed participated, for approximately how many years, when the student had last participated, and so forth.

General

Generally speaking, the student's self-reported data were used in the main analysis. Calculated data were used in additional analysis, as discussed elsewhere in this chapter and in the Results chapter. By calculating years of participation in OTU as well as years since participation, using both student and other data, it was possible to assess how much impact OTU had, and how that impact changed over time, with a larger total sample size.

See Appendices for respective survey question for the above variables.

Qualitative Responses

Qualitative responses by students to open-ended survey questions helped expand and deepen understanding of students' quantitative responses. These were supplemented with teachers' comments, as well as those of some principals and central school district personnel.

Sixth Grade Student Sample

Some sixth-graders were still in elementary school and participating in OTU when surveyed. These students are in a K-6 elementary school (Elementary School A), and then transfer to a Grades 7-8 middle school after completing sixth-grade. Other sixth-graders surveyed had attended K-5 elementary schools, and then transferred to a Grades 6-8 middle school, so they were not participating in the intervention at the time of the survey. As a result, sixth-graders surveyed could fall into one of three categories: (a) control (never participated in intervention); (b) participated in OTU only before sixth-grade (past participants, now at a middle school); (c) participated in OTU in sixth-grade (current participants, still at elementary school). The three-tier independent variable captured these categories.

Different regression models were run, including this three-tier, alternative OTU participation variable, as well as the standard student self-reported OTU participation independent variable. (The small sixth-grade sample size created a challenge, since the intervention group was subdivided by current and past participation as well as by sex. Further discussion of sample size issues will be addressed below.)

Regression Analysis

Regression analysis was used to understand the extent of influence of the independent variables on students' nutrition and physical activity. Regression allows us to compare the relative influence of different factors and to decide how confident we can be in explaining relationships between independent and dependent variables. While they do not prove that a cause-effect relationship exists, they can provide substantial support for predicting outcomes. Regression also permits identification of effects from interactions among variables, particularly when a student has two or more of the same characteristics as other students. In the present study, regression analysis allowed a comparison of the relative importance of the principal influential factors—grade, sex, SES, Hispanic ethnicity, and intervention participation—in terms of their relative impact on the nutrition and PA outcomes.

Logistic regression was used for all dependent variables, except for Nutrition Behavior, in which case the range and normal distribution of the variable allowed the use of a linear regression. Logistic regressions use a categorical approach, which indicates the probability of a certain binary outcome (e.g., the chances of eating fruit compared to eating a candy bar, based on the factors evaluated). The outcomes are stated as odds ratios or percentage probability. In contrast, linear regressions use a continuous approach, which indicates a predicted outcome value, for example, the predicted average number of pieces of fruit eaten daily by students, based on the actual values sampled.

Bivariate Analysis

Bivariate analysis with categorical variables was initially conducted to identify independent variables with the most apparent impact on dependent variables. This information helped to determine which variables to include in regression analyses and to

consider as possible candidates to measure interaction effects. Certain related dependent variables were then combined into "super-variables" to summarize variables into domains, as described above. Cronbach's alpha tests were conducted to assess internal reliability of these super-variables.

Multivariate and Regression Analysis

Both logistic and linear regressions were used, in order to calculate the association of independent variables with dependent variables, and to calculate the relative importance of key independent variables when different IVs are included together and when their interactions are considered. These statistical procedures helped to control for confounding influences.

Regression models were developed based on the underlying theoretical framework. Variables with a significance of $p < .20$ remained in models initially for further investigation. Final inclusion of variables into models was based on theoretical considerations and significance. Interactions across all independent variables were tested. Final significance level of interactions was as follows: $p < .05$ for interactions between a continuous and a categorical variable, or interaction between two categorical variables. In addition, $p < .10$ was considered influential. Curvilinear relationships were investigated visually with scatter plots and tested with polynomial regression terms.

For the logistic regression analysis, model fit was assessed by log-likelihood, specifically -2LL. For linear regression analysis, outcome variables were assessed for normal distribution, in order to assure randomly distributed residuals. If necessary, outcome variables were transformed in order to adjust for skewness and non-constant variance. All final regression models were assessed for violations of underlying assumptions, by assessing

residual plots for outliers, influential data points, equal variance of residuals, and curvilinear relationships. Model fit was assessed by R squared and the Akaike Information Criterion (AIC) measures. Best models were decided based on the theoretical framework and model fit.

The Chapter 4 Results section provides the key regression data for the most influential independent variables, their statistical significance, and how much impact they appear to have, in terms of effect size.

Finally, mixed effects model analysis, also referred to as hierarchical linear modeling (HLM), multilevel, or random-effects analysis, was used to review possible random effects. Successful regression models were re-run in mixed models format in order to determine whether similarities between students in schools (or even grade or teacher at the school) could have affected regression results:

> Hierarchical linear modeling (HLM) estimates linear equations that explain outcomes for members of groups as a function of the characteristics of the groups as well as the characteristics of the members. For example, these models can be used to predict salaries or job satisfaction for people within departments within companies based on the characteristics of those people, departments, and companies. The models are called hierarchical because they involve predicting the characteristics of members who are nested within some type of group, which may be nested with other groups inside a larger group. At each level, each member or group is in only one group at the next higher level. (Arnold, 1992, p. 58)

Graphing

Boxplots were used to assess the impact of the intervention on each principal dependent variable, based primarily on the number of years since participation in the intervention. These boxplots show the median by subgroup, the second and third quartiles just above and below the median, plus the end-points of the plot, showing the extreme high and low responses. The T-bar “inner fences” or “whisker” lines indicate the range of data

and amount of variability, and are intended to contain approximately 95% of the data (IBM SPSS, 2013). The boxplots reflect probability after controlling for independent variables, in order to minimize differences between the respondents being compared, so that the boxplots are as truly comparable over time as possible. Boxplot values are not actual data values, but are as predicted by the statistical model when keeping some confounders the same. In addition, outliers can be more influential in smaller sample sizes, and medians and quartiles may change substantially with a larger sample size. Nevertheless, the overall pattern of the boxplots is useful for understanding key trends over time (M. Rahn, personal communications, 2012-2013).

One set of boxplots graphs time since participation in OTU compared to control, while another set uses the three-tier intervention variable to compare current participants to all past participants as a group to non-participant students in the control group. The latter approach smoothes out year-to-year fluctuations among students who had participated in interventions in the past by grouping all past participants together. Years since participation was further split by sex, given the major impact of gender on key nutrition and PA dependent variables, as described elsewhere here. Where relevant, summary results by grade are also shown as another rough perspective on time since participation, with development stage also implied by the student's grade level.

When the total sample is split by time since intervention participation, and then split again into subgroups by sex, sample size (*n*) becomes small and attaining significant *p*-values becomes a challenge. Yet these subgroups are highly relevant, since grade, sex, and OTU participation are influential independent variables. In addition, tracking change over time is an essential component of analysis of long-term impact. The boxplots therefore supplement

the regression analysis by showing general trends by time since participation and/or by grade, and by sex. Nevertheless, due to high variability and/or lack of material differences between subgroup means, subgroups were hard to distinguish in certain boxplots.

Hypotheses

In the present study, I proposed that OTU participants would have better nutrition and exercise knowledge, attitudes, and behaviors, but that the difference between them and nonparticipants would narrow as the students move into higher grades and further away in time from their participation in the intervention, and as the effects of adolescence and nonreinforcement become more prominent. Likewise, the fewer the years that the student participated in the program, the faster that impact was expected to fade, and differences compared to the control group of nonparticipants to narrow.

Providing Results to Participants

Certain summary data will be provided in ways that would likely be of interest to principals and teachers who participated in the study, in particular. The dissertation itself can also provide more context, analysis, and discussion. Any study participant who has expressed interest will be notified, when the dissertation is published and available. A pdf of the dissertation will be forwarded, when requested. In addition, the school district will be provided with data as required by its "Request to Do Research" IRB policies, including protection of confidential data and participant privacy.

CHAPTER FOUR: RESULTS

Introduction

This chapter presents the results of the evaluation of Operation Tone-Up's (OTU) impact over time on school children in Maricopa County, Arizona. In this chapter, some descriptive general findings are outlined first. This is followed by presentation of the main statistical analysis of the data, beginning with nutrition-related outcomes, and followed by physical activity-related (PA) outcomes, and qualitative and other information.

The central question explored in the study is whether OTU makes a difference in the health-related knowledge, attitudes, and behaviors of school children. This is part of the larger research question inquiring about the long-term impact of in-school curriculum-based exercise and nutrition programs to prevent childhood obesity. The study seeks to understand whether any positive difference is related to participation in the OTU program intervention, and importantly, whether the *extent* and *timing* of students' participation in OTU matters. To this end, a series of regressions explored the impact of key participation-related variables, including factors such as age, grade, sex, income level (SES), and ethnicity (particularly Hispanic/non-Hispanic). Finally, boxplot graphs are shown after the regression analysis for each dependent variable, in order to help enhance the regression data, by illustrating the impact on health measures of time since participation in the intervention. Boxplots were graphed by time (time since participation in OTU compared to control, current vs. past participation vs. control, and in some cases grade) and then split further by sex. These graphs help to indicate how the impact of the intervention diminished over time as the

student moved into higher grades in middle school, and as time since participation in the intervention increased.

Further details, including a copy of the survey questionnaire, are in Appendix B.

The dependent variables, which attained statistical significance in relation to the intervention were *nutrition knowledge, nutrition behavior, physical activity attitude,* and *PA behavior*. *Nutrition attitude* was influential but did not meet the significance criterion at the .05 level. Overall, the results suggest that the intervention had major impact on students' nutrition and physical activity when both current and past participants are grouped together. Not surprisingly, the intervention had a particularly strong impact in the year it is offered. This impact is diluted over the years, such that when only years *after* participation in the intervention are included, (i.e., "past participants"), the effect size is smaller and less statistically significant than for current participants. The principal exception to the general trend of declining impact over time is *nutrition knowledge* among current compared to past participants. This may be due to past participants' longer exposure to middle school nutrition curriculum content, on top of their past exposure to OTU nutrition information, compared to current participants, who were all sixth-grade students, without 7^{th} and 8^{th} grade nutrition education.

Tables 4 and 5 summarize and contrast the intervention effect sizes for each of the three nutrition and three PA dependent variables in the principal models. The all participants column on the left side includes both current and past participants as one group, while the remaining two columns in the middle and on the right divide the sample into current or past participants, respectively. Nevertheless, the small sample size for current

participants requires a note of caution in drawing strong conclusions. Please see further below for more detailed data, including confidence intervals.

Table 4

Intervention Effect Sizes (odds ratios)

Outcomes (DVs)	*Notes*	Intervention		
	1	All Participants	Current Participants	Past Participants
Nutrition Knowledge	*2*	2.295*	2.075 [NS]	2.535**
Nutrition Attitude	*3*	1.684 [I]	NA	NA
Nutrition Behavior	*4*	1.0686 [I]	1.1822**	1.0210*
PA Attitude	*5*	5.445**	15.891*	0.959 [NS]
High PA Behavior		2.221*	9.662**	1.430 [NS]
Low PA Behavior	*6*	0.456*	0.263 [NS]	0.651 [NS]

Notes: Effect size is exp(β)=Odds ratio, except for continuous DV Nutrition Behavior effect size is 1 + β % of mean DV outcome to make roughly comparable to other effect sizes. For example, 2.295 Intervention effect size for Nutrition Knowledge means that intervention students' NK was [2.295-1.00=1.295]=129.5% higher than control students. Higher number is healthier, except for Low PA Behavior (see Note 6). >1 is positive effect size, <1 is negative/inverse. The principal reduced model results are shown.

1) Standard intervention IV in left Intervention column; three-tier intervention IV in right columns.

2) NK boxplots for past participants indicate that a small group of respondents with a high % of correct answers had a substantial impact on results, so past participant NK results should be treated with caution.

3) NA = statistically not significant, with p >.10)

4) NB IV converted to amount above sample mean [1+(.580/8.45)=1.0686], in order to show the percentage by which the intervention β was above the sample mean. This makes the NB effect size statistic in this table roughly similar to exp(B) odds ratios for other DVs. This reduced NB model excludes grade, which was significant in the full model. See NB section below for detailed notes.

5) For PA Attitude, exp(B) here is average of boys plus girls in interaction.

6) For Low PA Behavior, in contrast to other DVs, the inverse applies: >1 effect size is less healthy, <1 is healthier.

** p =< .05, ** p < .01, [NS]=Non-significant,[I]=Influential p<.10, NA=Not Applicable.*

Table 5

Intervention Effect Sizes (%)

Outcomes (DVs)	*Notes*	Intervention		
	1	All Participants	Current Participants	Past Participants
Nutrition Knowledge	*2*	129.5%*	107.5% [NS]	153.5%**
Nutrition Attitude	*3*	68.4% [I]	NA	NA
Nutrition Behavior	*4*	6.9% [I]	18.2%**	2.1%*
PA Attitude	*5*	675%**	1489.1%*	-4.1% [NS]
High PA Behavior		122.1%*	866.2%**	43.0% [NS]
Low PA Behavior	*6*	-54.4%*	-73.7% [NS]	-34.9% [NS]

Notes:Effect size is % difference from control based on exp(β)=Odds ratio, except for continuous DV Nutrition Behavior effect size is 1 + β % of mean DV outcome to make roughly comparable to other effect sizes. For example, 2.295 Intervention effect size for Nutrition Knowledge means that intervention students' NK was [2.2951-1.00=1.295] 129.5% higher than control students. Higher number is healthier, except for Low PA Behavior (see Note 4). >0% is positive effect size, <0% is negative. The principal reduced model results are shown.
1) Standard intervention IV in left Intervention column; three-tier intervention IV in right columns.
2) NK boxplots for past participants indicate that a small group of respondents with a high percentage of correct answers had a substantial impact on results, so past participant NK results should be treated with caution.
3) NA = statistically not significant with p > .10).
4) NB IV converted to % above sample mean [.580/8.45=.0686=6.9%], in order to show the percentage by which the intervention β was above the sample mean. This makes the NB effect size statistic in this table roughly similar to exp(B) odds ratios for other DVs. This reduced NB model excludes grade, which was significant in the full model. See NB section below for detailed notes.
5) For PA Attitude, exp(B) is average of boys plus girls in interaction.
6) For Low PA Behavior, in contrast to other DVs, the inverse applies: >1 effect size is less healthy, <1 is healthier.
** p =< .05, ** p =< .01, [NS] = Non-significant, [I] = Influential p =< .10, NA = Not Applicable.*

Statistical significance for comparisons between subgroups was heavily influenced by the number of students in each sub-group sample, particularly among the smaller pool of sixth-grade students.

Regression and Related Analysis

The regression analysis focused on key independent variables based on a cross-tabs analysis of pairings of each independent variable with the intervention variable, as discussed in Chapter 3. The independent variables (IV) which were consistently the most influential across both nutrition and PA were sex, grade, SES (receives free lunch), Hispanic ethnicity, and participation in the intervention. These demographic non-intervention IVs have often been significant nutrition and PA predictors in the literature, so their association with students' outcomes was expected. These were identified as the key independent variables to include in regressions, as the most likely explanatory variables for nutrition and PA knowledge, attitude, and behavior. Interactions of key IVs were considered, and interactions are shown when significant. Interactions of SES and sex for *nutrition knowledge*, and intervention participation and sex for *PA attitude*, were found to be significant.

For logistic regressions, the significance of the likelihood ratio chi-square indicates whether the model was performing better than the intercept model, and therefore whether the model fits the data. Unstandardized logistic regression coefficients (log β) and odds ratios (exp(β)) represent effect size. Lower (LCI) and upper (UCI) confidence intervals show the 95% probability range for the particular independent variable, equivalent to a .05 level of statistical significance. In other words, there is a 95% probability that the actual data are between the lower and upper confidence intervals, and a 95% probability that results would be found in this range if the study were repeated again, whereas only a 5% probability that the results have occurred by chance or sampling error, and are therefore invalid. The predictive power of each logistic regression model can be interpreted in terms of Cox-Snell R^2 and Nagelkerke R^2, which attempt to provide an analogous measurement to R^2 in linear

regressions. The Nagelkerke R^2 adapts the Cox-Snell measure so that it varies from 0 to 1, as in linear regressions; the Nagelkerke measure is shown here. *P*-values below .05 are judged statistically significant, while *p*-values of .05-.10 are judged nonsignificant but influential. *P*-values below .01 are also noted. The reduced principal best models, which include only the most influential IVs for a given dependent variable, are shown below the full model where relevant.

Students were identified as participants in the control or intervention groups, based on their own recollection as to whether they had participated. As described in Chapter 3, the standard intervention IV creates a control and an intervention group, while the three-tier intervention IV separates current intervention participants from past participants. Both the standard intervention IV and the alternative three-tier intervention variable were run separately in different regression models for each key dependent variable.

Each regression model shown was significant at $p < .001$, indicating that the models were performing better than the intercept model and fit the data.

In addition to regression analyses, hierarchical linear models (HLM) analyses were run, since data for participants are organized at multiple levels, particularly by the school, teacher, and individual student. HLM analysis helps to determine whether certain schools or teachers might have had an impact and provides further explanations for the results. No significant random effects issues were found.

Graphing

Boxplots were graphed by time (by time since participation in OTU compared to control, and in some cases by grade) and then split further by sex. The boxplots show the median by sub-group, the second and third quartiles just above and below the median, plus

the "whisker lines" and end-points of the plot, illustrating the range of data. Reinforcing the regression analysis, the boxplots show significant differences in outcomes for a number of dependent variables, in terms of the intervention's impact on nutrition knowledge, attitude, and behavior and physical activity attitude and behavior. Note that the group of students who participated in the intervention 2½ years prior to the present study has a particularly large sample size (n = 66), while the group of students who participated 1½ years ago is relatively small (n = 14), as is the group that participated 4½ years prior to the present study (n = 4). Results from such small groups are prone to sampling error and should be treated with caution.

Table 6

Years Since Intervention Participants last Received Intervention

Parameter	Intervention					Control
Years Since Participation	.5	1.5	2.5	3.5	4.5	NA
n	24	14	66	24	4	238
%	6.5%	3.8%	17.8%	6.5%	1.1%	64.3%

As expected from the hypothesis, the boxplots reflect the decline over time of the intervention impact. As one follows the outcomes over years-since-intervention and grades, the gaps between control and intervention outcomes narrow across all dependent variables. These results strongly suggest that the impact of the intervention wears off without follow-up.

The sections to follow address detailed analyses of each dependent variable. The first part of the detailed analysis below focuses on nutrition-related analysis, followed by physical activity analysis.

Nutrition Knowledge

To measure nutrition knowledge, as described in Chapter 3, a super-variable was used to consolidate the responses from three nutrition knowledge questions into one: whether the student understood the roles of the protein, carbohydrates, and metabolism. If the student answered all three questions correctly, the response was coded as 1, otherwise the variable was coded as 0 as the reference category. The number of respondents (*n)* was 233 in the model using the standard intervention variable.

As shown in Tables 7 and 8, the results of the study indicate that the intervention had a significant impact on students' nutrition knowledge. In contrast to other nutrition-related dependent variables measured, the biggest impact was on students who participated in the intervention in the past. The intervention impact faded over time for former participants, as the time since they had participated increased. Unlike other dependent variables, nutrition knowledge did not fade away for middle school students in general, as they aged and moved up in grades.

In the final regression model for nutrition knowledge, the intervention and the interaction of sex and SES emerged as significant predictors of nutrition knowledge. Self-identification as Hispanic or non-Hispanic was not a significant predictor of nutrition knowledge. In other words, there was no important difference in nutrition-related knowledge between students who participated vs. did not participate in Operation Tone-Up, when considered by Hispanic compared to non-Hispanic students.

Intervention students as a whole were 2.3 times more likely than control students to answer all nutrition knowledge questions correctly (β = 0.831, exp(β) = 2.295, p = .013). The interaction of sex and SES showed significant differences (β = -1.549, exp(β) = 0.212, p = .030) in boys compared to girls, particularly depending on their SE status. These results indicated that boys with high SES had much greater odds of correct nutrition knowledge than their female high SES peers and all low SES students, after controlling for intervention.

Table 7

Nutrition Knowledge Outcome (standard intervention IV)

logistic regression with independent variables; n=233; -2LL = 242.759; R^2 = .160; omnibus test p = .000; reduced model

Variable	β	*p*	Odds ratio	95% CI	
				LL	UL
Intercept	-2.081**	.000**	0.125	0.046	0.341
Sex	1.796 (see interaction)	.002**	6.023	1.948	18.623
SES	0.110 (see interaction)	.846 [NS]	1.116	0.370	3.369
Hispanic	NA	NA			
Intervention	0.831*	.013*	2.295	1.189	4.428
Interaction	-1.549*	.030*	0.212	0.052	0.863

Calculated odds ratio of interaction:	Sex	SES	
High SES Boys	1	0	6.02
Low SES Boys	1	1	1.43
High SES Girls (reference)	0	0	1.00
Low SES Girls	0	1	1.11

Notes: Nutrition knowledge: 1 = all answers correct, 0 = at least one answer incorrect; reduced, final model, using standard intervention IV values; shown are β, log coefficient. Sex: 1 = boy, 0 = girl; SES = self-reported free lunch recipient: 1 = yes, 0 = no. Other sample descriptives: 57 responded correctly on all questions, while 176 answered incorrectly on at least one question; 95 respondents had participated in the intervention, while 138 were in the control group.
** p =< .05, ** p =< .01, [NS] = Non-significant, [I] = Influential p =< .10, NA = Not Applicable. odds ratio: [95% CI=confidence interval: LL=lower limit; UL=upper limit].*

The three-tier intervention IV separates students currently participating in the intervention from students who received the intervention in the past, but are not receiving it currently. The small sample size of *n* = 19 for the *nutrition knowledge* variable for current intervention participants compared to *n* = 86 for past intervention participants means that statistical significance was more challenging to achieve for current students. For past participants, the high β (.930) and odds ratio (2.535) were highly significant (*p* = .004), 95% CI [1.346, 4.773]. These results indicated a substantial intervention impact on nutrition knowledge among past intervention participants. Statistical significance was not achieved for students currently in the intervention program, but the small sample size may have been too underpowered to demonstrate significant results.

Table 8

Nutrition Knowledge Outcome (three-tier intervention IV)

logistic regression with independent variables; n=278; -2LL = 294.181; R^2 = .111; *omnibus test p = .000; reduced model*

Variable	β	*p*	Odds ratio	95% CI	
				LL	UL
Intercept	-1.488**	.000**	0.226	0.120	0.425
Sex	0.830**	.006**	2.293	1.268	4.144
SES	-0.810**	.008**	0.445	0.244	0.811
Intervention					
Currently participating	0.730	.185 [NS]	2.075	0.706	6.1000
Participated in past	0.930**	.004**	2.535	1.346	4.773
Interaction	NA				

Notes: Nutrition knowledge: 1 = all answers correct, 0 = at least one answer incorrect; final model, using three-tier intervention IV; values shown are β, log coefficient. Sex: 1 = boy, 0 = girl; SES = self-reported free lunch recipient: 1 = yes, 0 = no. Other sample descriptives: current students are a small sample size of n=19 compared to n=86 past intervention participants. NK boxplots for past participants indicate that a small group of respondents with a high % of correct answers had a substantial impact on results, so past participant NK results should be treated with caution.
** p =<.05, ** p =< .01, [NS] = Non-significant, [I] = Influential p =< .10, NA = Not Applicable.*
odds ratio: [95% CI=confidence interval: LL=lower limit; UL=upper limit].

The boxplot graphs below indicate outcome results over time, both by grade, and by years since participation in the intervention. *Nutrition knowledge* is unique among the dependent variables reviewed. Median scores for correctly selecting all three nutrition knowledge answers actually increase over time, as seen in the Figure 2 below, as students progress through grades. According to school district personnel, in keeping with state curriculum standards, middle school students in this school district learn key facts about the roles of protein, carbohydrates, and metabolism at school (Curriculum Director of School District, personal communications, 2013). Ongoing education in nutrition, therefore, may have confounded the differences between students in the intervention and control groups.

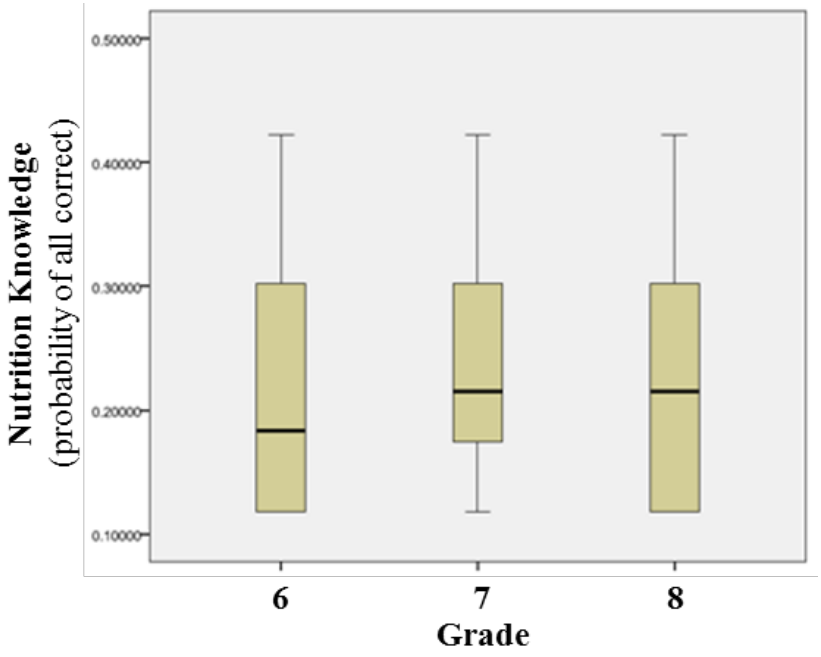

Figure 2. Nutrition knowledge by grade.

Figure 3 demonstrates changes in nutrition knowledge in the years following participation in the intervention. Student data from participants in the intervention are compared to the control group data (right plot in Figure 3). Nutrition knowledge during the intervention is higher than students in the control group, as shown by the left boxplot, but intervention students' knowledge in the years after participation (plots at 1.5, 2.5, 3.5, and 4.5 years) is comparable to or less than the control group. Participation in the intervention before the current year may not have more impact on past participants' present nutrition knowledge than what these students seem to be learning during their middle school years.

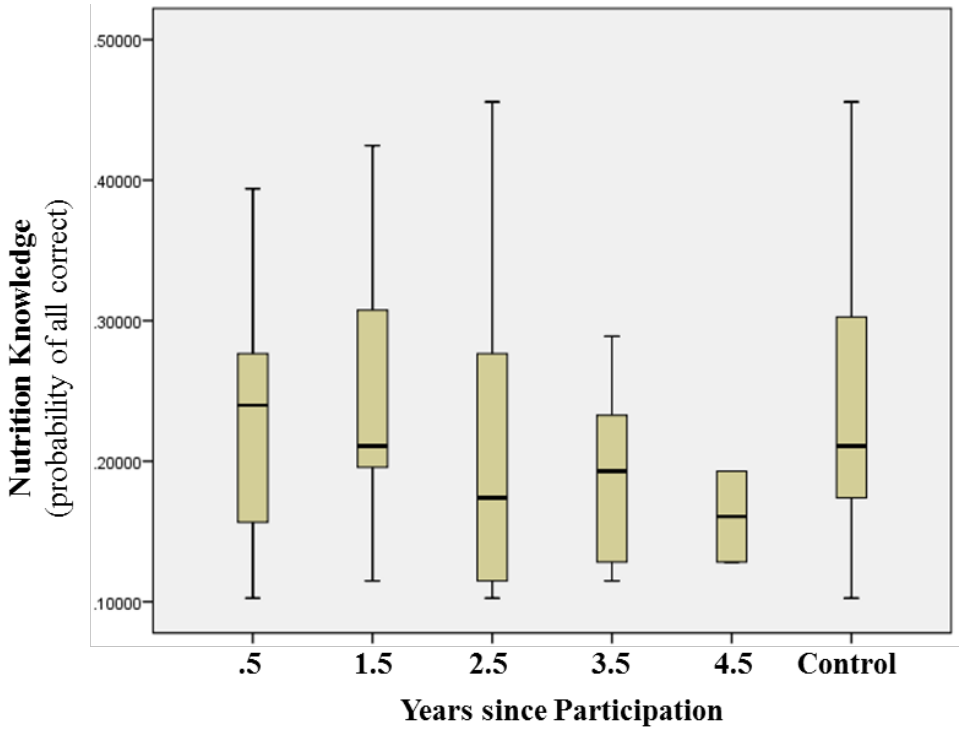

Figure 3. Nutrition knowledge by years since intervention participation.

Figure 4 compares data from all past intervention participants (middle column) with data from control students (left column), and current participants (right column). Median nutrition knowledge for past intervention program participants is lower than for control students, while it is higher for current intervention participants. Sample size, lower average grade level of participants, and other factors may account for some of these differences, which are considered in more detail in the discussion section.

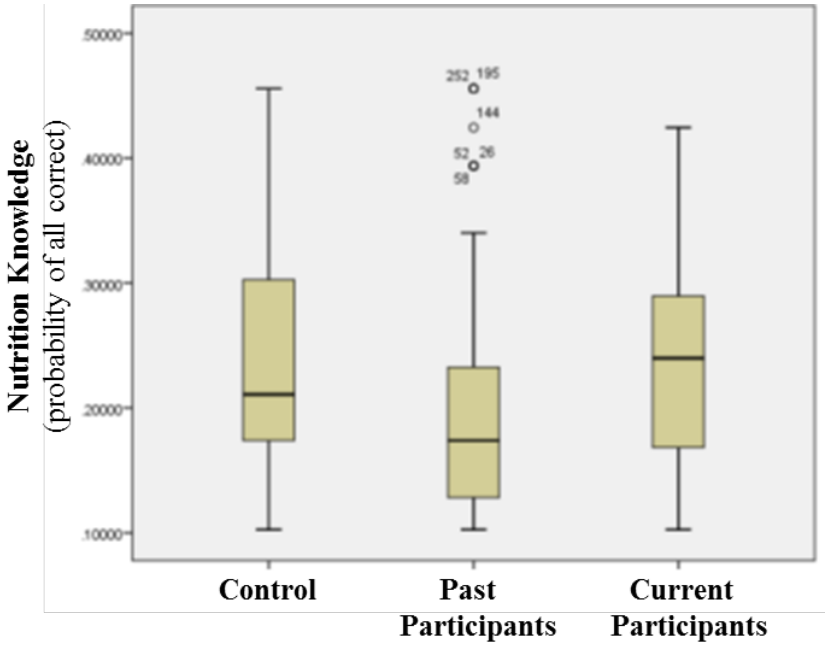

Figure 4. Nutrition knowledge by control, past, & current participation.

In Figure 5 below, differences in nutrition knowledge are presented by sex in separate panels. The boxplots reveal sharp differences between boys' and girls' nutrition and physical activity as shown in the upper and lower panels, respectively. The data indicate that boys absorb and retained much more information on protein, carbohydrates, and metabolism than the girls in the present study.

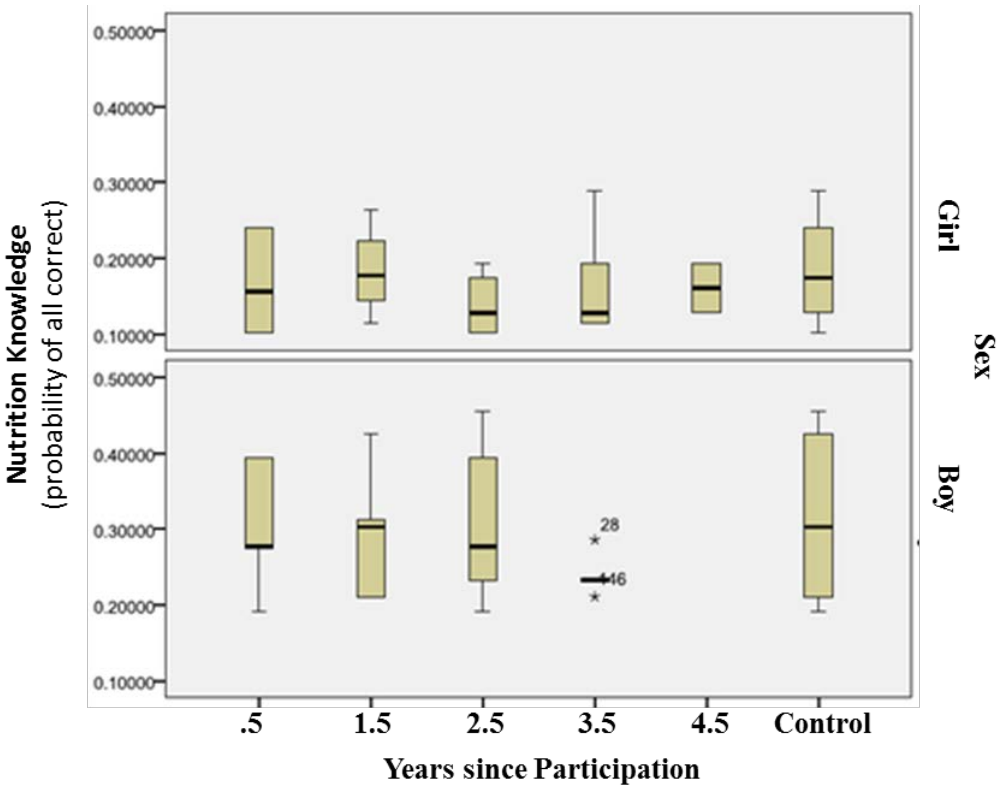

Figure 5. Nutrition knowledge by sex & years since intervention participation.

Nutrition Attitude

To measure nutrition attitude, a super-variable was used to consolidate the responses from two nutrition attitude questions: whether the student preferred to eat fruit or a candy bar for a snack, together with whether the student preferred to drink water or a soda. Students were divided into two groups: those who chose both healthy answers, compared with those who selected one or more unhealthy choices. If the student answered both questions healthily, the variable was coded as 1, otherwise the variable was coded as 0 as the reference category. Respondent sample size (*n)* was 232 in the model using the standard intervention variable.

Nutrition attitude, unlike nutrition knowledge, but similarly to other outcomes, became less healthy over time among students surveyed. Intervention participants' nutrition attitudes were healthier during and shortly after participation, but this difference faded over time, approaching the level of control students. The principal model was significant at $p < .01$, indicating that the model was performing better than the intercept model and fit the data; -2LL for the principal model was 306.271, and Nagelkerke R^2 was .085.

The results indicated that grade played a significantly negative role in nutrition attitude ($\beta = -0.409$, odds ratio = 0.665, $p = .027$), whereas sex, SES, and self-identification as Hispanic or non-Hispanic were not significant. While intervention participation was not statistically significant, it was influential ($p = .076$), and judging by effect size measures, intervention participation may have had substantial impact ($\beta = 0.521$, odds ratio = 1.684). Even when age is centered—that is, the overall sample mean of age is subtracted from the individual values of age and set at 0, and the individual values are then spread around 0 in order to help reduce the collinearity effect—intervention participation remains influential ($p = .078$), with only a slight drop in effect size ($\beta = 0.452$, odds ratio = 1.571). (Age and grade are closely associated, so when age is factored in as an independent variable, grade loses significance and is dropped.)

Table 9

Nutrition Attitude Outcome (standard intervention IV)

logistic regression with independent variables; n=232; -2LL = 306.271; R^2 = .085; omnibus test p = .009; standard intervention IV (full model)

Variable	β	*p*	Odds ratio	95% CI	
				LL	UL
Intercept	2.436	.073 [I]	11.430	0.796	164.143
Sex	-0.066	.811	0.936	0.543	1.612
SES	0.173	.583 [NS]	1.189	0.641	2.206
Hispanic	0.316	.291 [NS]	1.372	0.763	2.465
Grade	-0.409	.027*	0.665	0.463	0.954
Intervention	0.521	.076 [I]	1.684	0.947	2.997

Notes: Nutrition attitude: 1 = all answers healthy, 0 = at least one answer unhealthy; final model, using standard intervention IV values; shown are β, log coefficient. Other sample descriptives: 115 responded healthily on both questions, while 117 answered unhealthily on at least one question. 95 respondents had participated in the intervention, while 137 were in the control group.
** p =< .05, ** p =< .01, [NS] = Non-significant, [I] = Influential p =< .10, NA = Not Applicable.*
odds ratio: [95% CI=confidence interval: LL=lower limit; UL=upper limit].

The three-tier intervention variable differentiating between currently participating students and past participants did not appear influential, and is not shown.

The boxplots in Figure 6 demonstrate that the nutrition attitude of intervention students worsens substantially over time as the time since intervention participation increases. While intervention students' median score remains higher than control students, even among students who have not participated for 2½ years, the *p*-value for the intervention (.076) suggests a marginal effect since it does not meet the criterion for statistical significance established for this study ($p = .05$). The relatively low median of the group measured 1.5

years after participation seems likely to be due to the small sample size of that group (n = 14).

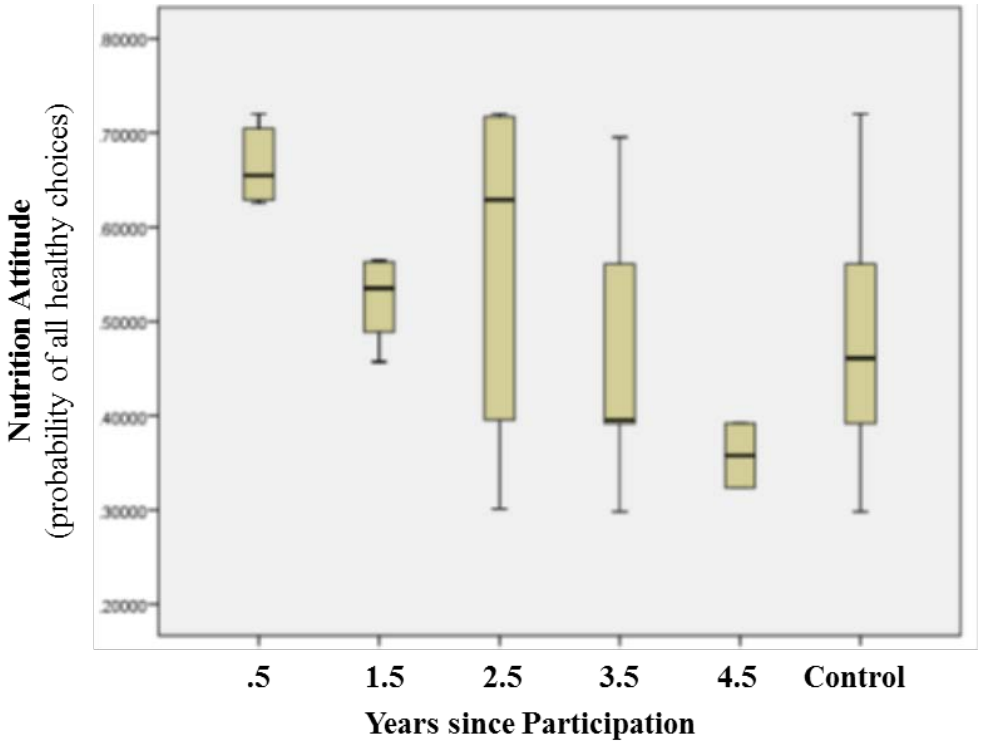

Figure 6. Nutrition attitude by years since intervention participation.

Figure 7 compares data from all past intervention participants (middle column) with data from control students (left column), and current participants (right column). These results support the more detailed years-since-participation graph. They show a major intervention effect in the year of intervention, and a much lower long-term impact post-intervention. A slightly higher median for past participants compared to control students reinforces information from Figure 6 above, showing some persistence of nutrition attitude learning in the initial years after participation.

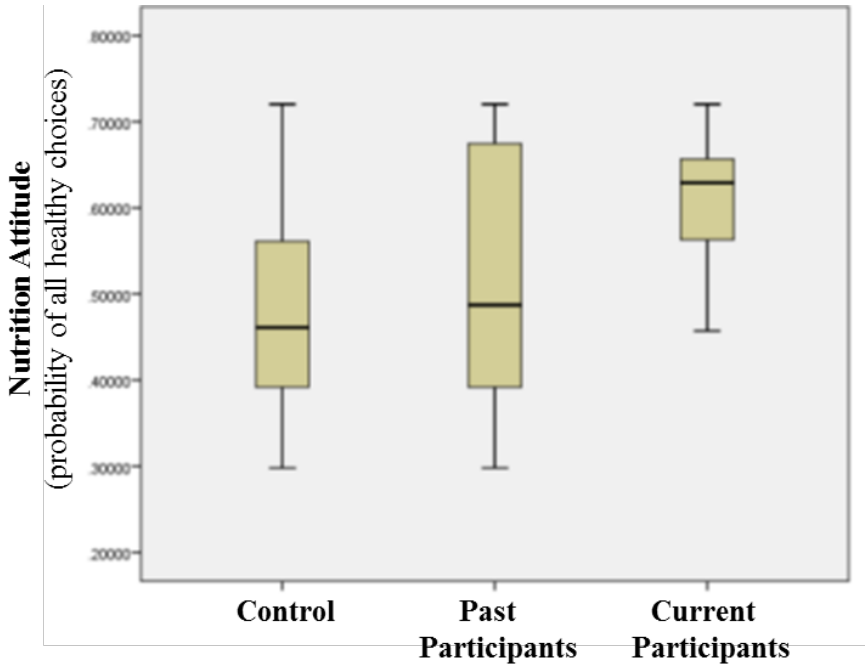

Figure 7. Nutrition attitude by control, past, & current participation.

The pattern of declining impact appears similar between boys and girls, as might be expected from the lack of significance of sex as an independent variable for *nutrition attitude*, as shown in the panel plots in Figure 8 below.

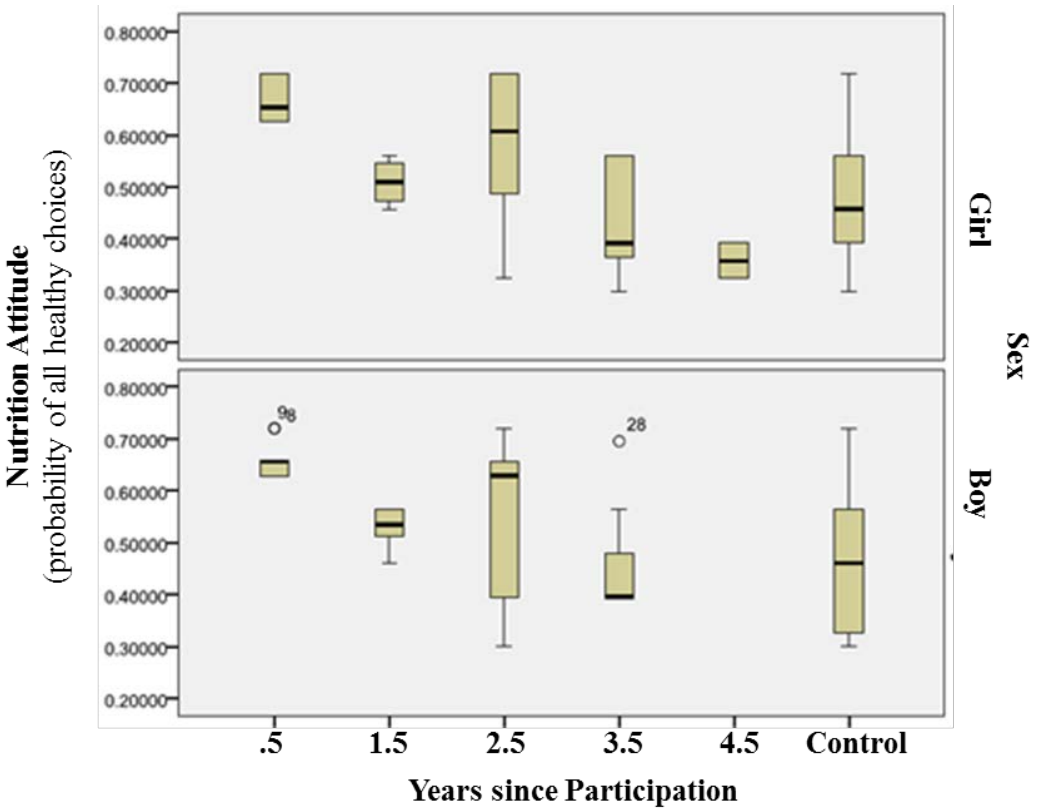

Figure 8. Nutrition attitude by sex & years since intervention participation.

Nutrition Behavior

To measure nutrition behavior, a super-variable was used to consolidate self-reported student responses from three nutrition behavior questions into one variable: When was the last time that the student reported eating fruit, how many times per day does the student eat fruit or vegetables, and how many times per day does the student drink soda? Number of respondents (*n)* was 218 in the models using the standard intervention variable, and the mean outcome was 8.45 out of a possible 12.0 for having the healthiest behavior, with a standard deviation of 2.3769.

The results from a linear regression indicate that the grade level and the SES of the participant had significant effects on students' nutrition behavior, and that the intervention effects and their significance varied, as shown in Tables 10-12 below.

In the full linear model using the standard intervention variable, the model was significant at $p < .05$, indicating that the model was performing better than the intercept model and fit the data. AIC was 997.609, and adjusted R^2 was .029, with a standard error of estimate of 2.3430. Grade ($p = .028$) and SES ($p = .034$) were significant, while sex, self-reported Hispanic or non-Hispanic ethnicity, and intervention participation were not. SES ($\beta = -0.768$, $p = .028$), and Grade ($\beta = -0.469$, $p = .034$) were shown to have significant effects on nutrition behavior. Other variables including the intervention were not significant.

Table 10

Nutrition Behavior Outcome (standard intervention IV; full model)

linear regression with independent variables; n=218; AIC 997.609; Adjusted R^2 = .029; standard error of estimate = 2.3420; omnibus test p = .042; standard intervention IV (full model)

Variable	β	*p*	95% CI	
			LL	UL
Intercept	12.042	.000**	8.931	15.154
Grade	-0.469	.028*	-0.889	-0.050
Sex	0.010	.976	-0.617	0.637
SES	-0.768	.034*	-1.478	-0.058
Hispanic	0.250	.468	-0.426	0.926
Intervention	0.285	.411	-0.395	0.966

Notes: Nutrition behavior: 0=least healthy responses on all three questions, 1=most healthy responses on all three questions; full model, using standard intervention IV values; shown are β [effect size], log coefficient. Sex: 1=boy, 0=girl; SES = self-reported free lunch recipient: 1=yes, 0=no; Hispanic: 1=yes, 0=no. Other sample descriptives: mean DV outcome=8.45, with a standard deviation of 2.3769; 90 respondents had participated in the intervention, while 128 were in the control group.
** p =< .05, ** p =< .01, [NS] = Non-significant, [I] = Influential p =< .10, NA = Not Applicable.*
odds ratio: [95% CI=confidence interval: LL=lower limit; UL=upper limit]

Although grade was significant in the full model, it was dropped in the reduced model, due to collinearity between grade and the intervention variable. In the reduced model using the standard intervention variable and SES, AIC was 996.611, indicating a slightly better fit than the full model (AIC = 997.609), as indicated above in Table 11. Adjusted R^2 was .017. With grade removed from the model because of collinearity with the outcome variable, and sex and Hispanic removed from the full model because of lack of significance, intervention participation continued to fail to meet the criterion for statistical significance ($p = .05$), but was marginally influential ($\beta = 0.580$, $p = .073$). The positive correlation coefficient indicates that intervention students had higher nutrition behavior scores than student in the control groups, but that students with lower SES, as indicated by eligibility for free lunch, scored lower than intervention students for nutritional behaviors ($\beta = -0.686$, $p = .041$). The mean responses for students in the present study indicate that students participating in the intervention scored, on average, 0.58 points higher than control students, after adjusting for SES. Likewise, students receiving free lunch have an average score that is 0.69 points lower than students not receiving lunch, after controlling for intervention.

Table 11

Nutrition Behavior Outcome (standard intervention IV; reduced model)

linear regression with independent variables; n=218; AIC 996.611; Adjusted R^2 = .017; standard error of estimate = 2.3237; omnibus test p = .038; standard intervention IV (reduced model)

Variable	β	*p*	95% CI	
			LL	UL
Intercept	8.660	.000	8.091	9.230
SES	-0.686	.041*	-1.343	-0.029
Intervention	0.580	.073 [I]	-0.055	1.214

Notes: Nutrition behavior: 0=least healthy responses on all three questions, 12=most healthy responses on all three questions; reduced model, using standard intervention IV values, including dropping grade; shown are β [effect size], log coefficient. SES = self-reported free lunch recipient: 1 = yes, 0 = no. Other sample descriptives: mean DV outcome=8.45, with a standard deviation of 2.3769; 90 respondents had participated in the intervention, while 128 were in the control group. This reduced model excludes grade, which was significant in the full model (above).
** p =< .05, ** p =< .01, [NS] = Non-significant, [I] = Influential p =< .10, NA = Not Applicable.*
odds ratio: [95% CI=confidence interval: LL=lower limit; UL=upper limit].

Number of respondents (*n*) was 263 in the principal model using the three-tier intervention IV variable. The mean DV outcome for the three-tier model was 8.399 out of a possible 12.0, with a standard deviation of 2.3042. AIC was 1180.613, and adjusted R^2 was .027. Low SES was coded as 1, and higher SES was coded as 0 as the reference. Given the coding scheme used in the current study, the negative regression coefficient (β = -0.737) indicates that students with lower SES had lower scores on self-reports of healthy nutritional choices. On average, higher SES students had scores on nutrition behavior that were 0.737 points higher than their lower SES peers, suggesting a healthier response. These findings were statistically significant (p = .013). Students currently participating in the intervention had scores that were 1.530 points (p = .005) higher than the control students, while average

scores for past intervention participants were 0.176 points higher (p = .018) than students in the control group. Intervention participation might compensate for a SES-related nutrition behavior disadvantage.

Table 12

Nutrition Behavior Outcome (three-tier intervention IV)

linear regression with independent variables; n=263; AIC=1180.613; R^2=.027;
omnibus test p = .003; reduced model

Variable	β	*p*	95% CI	
			LL	UL
Intercept	9.518**	.000**	8.489	10.548
SES (low SES=1 as reference)	-0.737*	.013*	-1.315	-0.158
Intervention				
Participated in past	0.176	.018*	0.058	0.409
Currently participating	1.530	.005**	0.466	2.594

Notes: Nutrition behavior values: 0=least healthy responses on all three questions, 12=most healthy responses on all three questions; reduced model, including dropping grade, and using three-tier intervention IV; values shown are β [effect size], log coefficient. SES = self-reported free lunch recipient: 1 = yes, 0 = no (inverted to make SES β comparable to other SES effect sizes for other DVs). *Also, intervention IV values are inverted to make more comparable to other DV models. Other sample descriptives: mean DV outcome=8.399, with a standard deviation of 2.3042; students currently participating in intervention are a small sample size of n=19 compared to n=81 past intervention participants and control n=163. This reduced model excludes grade, which was significant in the full model (above).*
** p =< .05, ** p =< .01, [NS] = Non-significant, [I] = Influential p =< .10, NA = Not Applicable.*
odds ratio: [95% CI=confidence interval: LL=lower limit; UL=upper limit]

Figure 9 compares data from intervention participants based on the number of years since they last participated in the intervention to the control group of students. These plots demonstrate that *nutrition behavior* exhibits a similar pattern to *nutrition attitude*. Students report eating less fruit and drinking more soda as they age and move into higher grades. Similarly to *nutrition attitude*, this result implies persistence of healthier nutrition behavior

among intervention participants than among students in the control group in the initial years after participation.

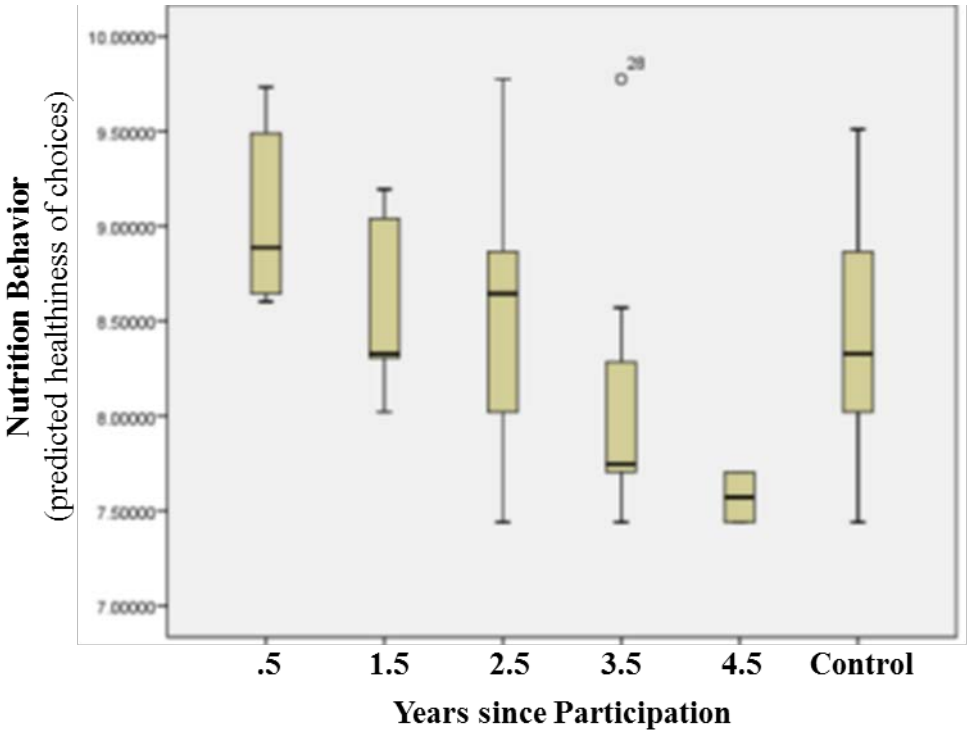

Figure 9. Nutrition behavior by years since intervention participation.

In Figure 10 below, data from control groups, current participants, and past participants are grouped in individual columns. Control students are in the left column, past participants in the middle column and current participants in the right column. The plots in Figure 10 show that median scores for nutrition behavior for past participants are almost the same as for control students. These results support the more detailed years-since-participation graph (Figure 9), revealing a major intervention effect in the year of intervention, and a much lower long-term impact post-intervention.

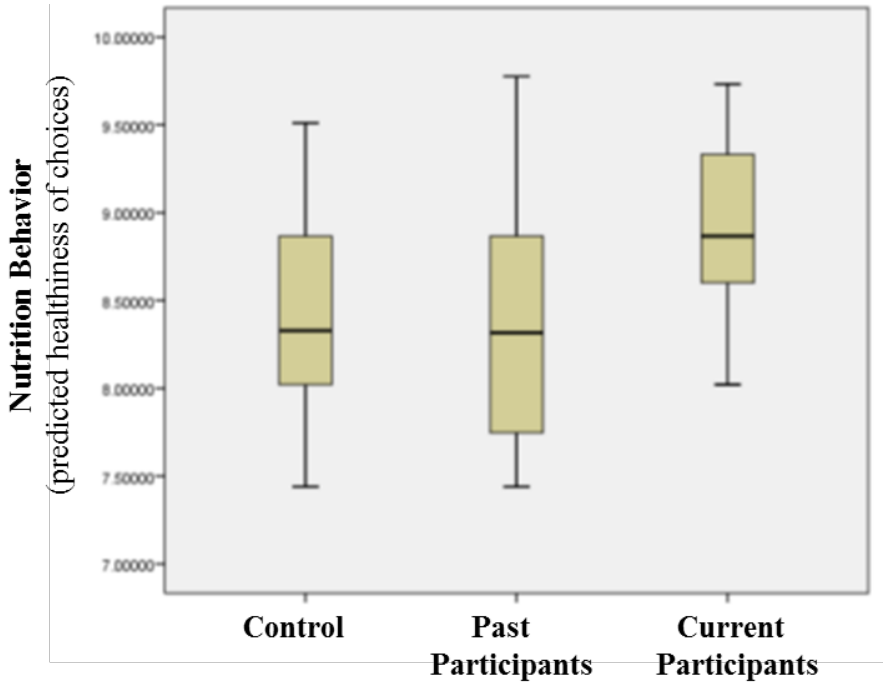

Figure 10. Nutrition behavior by control, past & current participation.

In Figure 11 below, differences in nutrition behavior are presented by sex in separate panels. Comparing results in the boxplots by sex and contrasting them to Figure 9, which showed overall differences by years since participation, is revealing. For students as a whole who participated in the intervention in the prior year (1½ years ago), the sharp downward drop may be due in part to the less healthy behavior reported by boys in the sample; girls' scores showed a less sharp decline 1½ years after participation, and their median score was higher than the overall control median score. However, as noted earlier, the 1.5 years after participation sample size is quite small (n = 14), so data for this subgroup should be interpreted with caution.

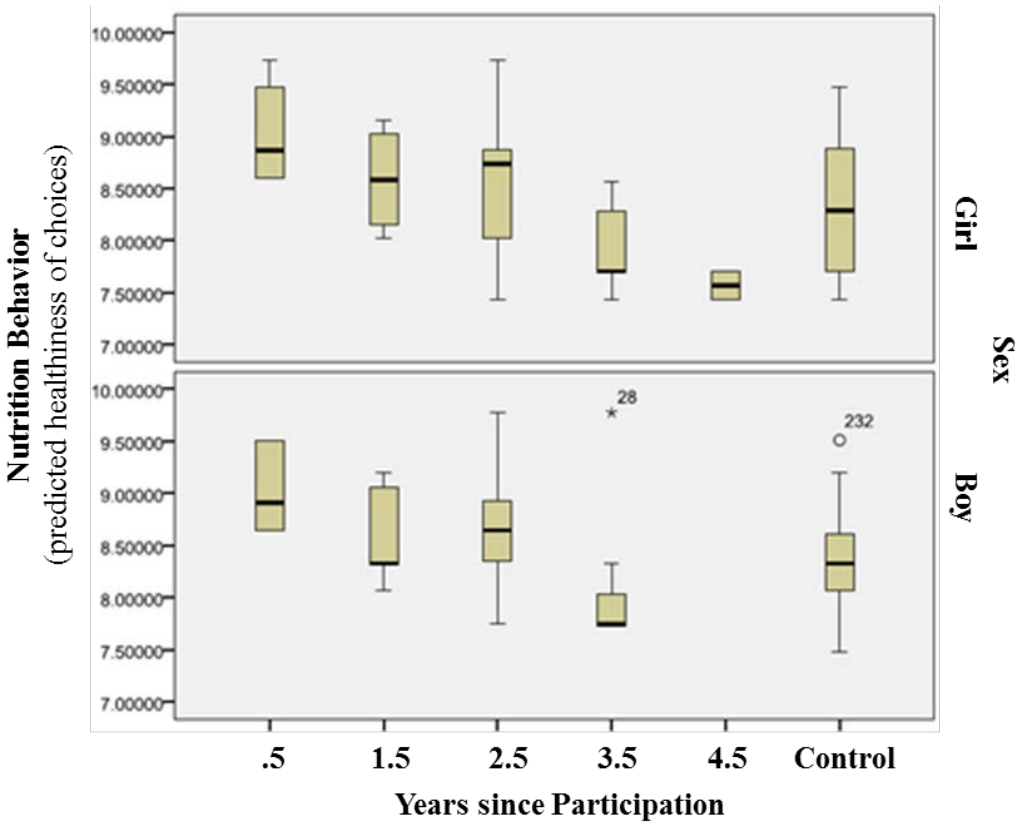

Figure 11. Nutrition behavior by sex & years since intervention participation.

We now turn to evaluating physical activity-related outcomes.

Physical Activity Attitude

To measure physical activity attitude, the independent variable preference was used; the student reported her/his preference for talking with friends at recess compared to playing a running game with friends during recess. While this choice between activities does not mean that students who talked with friends were inactive, the choice did indicate a preference for talking with rather than playing a running game with friends, implying less

physical activity than among students who chose playing with friends. If the student chose the more active PA response of running at recess, the variable was coded as 1, otherwise the variable was coded as 0 as the reference category. Respondent sample size (*n)* was 234 in the model using the standard intervention variable, including both boys and girls. The principal model was significant at $p < .001$, indicating that the models were performing better than the intercept model and fit the data; -2LL for the principal model was 319.945, and Nagelkerke R^2 was .308.

The results indicated that as students moved into higher grades, their preference for physical activity decreased. Developmental trends in adolescence apparently undermined students' PA. For each one-unit increase in grade, the odds of preferring physical activity (PA attitude) decreased by a factor of 0.361 ($p < .001$), or 64% per grade level ($\beta = -1.018$, odds ratio = 0.361 minus 1.00 = -0.639). In other words, for each advance in grade level, the odds that a student prefers talking to physical activity are 2.77 times higher than the year before (inverse odds ratio = 1/.361).

Gender played a major role in PA outcomes including PA attitude. While girls in the intervention group had a lower preference for PA than boys, intervention girls benefited materially, in a statistically significant manner, compared to girls in the control group. The intervention had a significant impact on girls (interaction $p = .000$). The odds that girls who received the intervention would prefer to play running games with their friends at recess rather than to simply talk to them was 5.43 times higher than girls in the control group. On the other hand, the odds that boys in the control group would state a preference for running games at recess is ten times greater than for girls in the control group, and nearly four times greater than for intervention girls. This appears to be further evidence of the trend for

adolescent girls to become less physically active than boys. Paradoxically, boys in the control group have an even healthier PA attitude than intervention boys. Students in the control group had a higher average SES than intervention students, which might help explain the difference among boys.

Table 13

PA Attitude Outcome (standard intervention IV)

logistic regression with independent variables; n=234; -2LL = 242.759; R^2 = .160; omnibus test p = .000; reduced model

Variable	β	*p*	Odds ratio	95% CI	
				LL	UL
Intercept	5.003	.001**	148.826	6.973	3176.424
Grade	-1.018	.000**	0.361	0.234	0.557
Sex	3.004 (see interaction)	.000**	20.176	7.517	54.152
Intervention	1.695 (see interaction)	.001**	5.445	2.044	14.507
Interaction	-2.388	.000*	0.092	0.024	0.348

Calculated odds ratio of interaction:	Sex	Intervention	
Control Boys	1	0	20.11
Intervention Boys	1	1	10.06
Control Girls (reference)	0	0	1.00
Intervention Girls	0	1	5.43

Notes: PA attitude: 1 = more active response, 0 = less active response; final model, using standard intervention IV values; shown are β, log coefficient. Sex: 1 = boy, 0 = girl; SES = self-reported free lunch recipient: 1 = yes, 0 = no. Other sample descriptives: 99 responded healthily on both questions, while 135 answered unhealthily on at least one question. 96 respondents had participated in the intervention, while 138 were in the control group.
** p =< .05, ** p =< .01, [NS] = Non-significant, [I] = Influential p =< .10, NA = Not Applicable. odds ratio: [95% CI=confidence interval: LL=lower limit; UL=upper limit]*

When the three-tier intervention variable was used, only currently participating students had a significantly (p = .011) healthier PA attitude than control students, though sample size was only 20. Nevertheless, the odds ratio related to higher PA attitudes was high (15.891), potentially indicating a much healthier PA attitude among intervention students, though the broad confidence interval indicates a need for caution in interpretation. What is more, intervention participation could perhaps far eclipse the negative effect of higher grade levels (β = -0.852, odds ratio = 0.427, p = .000), if the intervention were continued in higher grades.

Table 14

PA Attitude Outcome (three-tier intervention IV)

logistic regression with independent variables; n=280; -2LL = 399.673; R^2 = .274; *omnibus test p = .000; reduced model*

Variable	β	*p*	Odds ratio	95% CI	
				LL	UL
Intercept	4.729	.001**	113.174	6.216	2060.686
Grade	-0.852	.000**	0.427	0.283	0.643
Sex	1.768	.000**	5.860	3.272	10.495
Intervention					
Currently participating	2.766	.011*	15.891	1.905	132.588
Participated in past	-0.042	.892	0.959	0.522	1.761

Notes: PA attitude: 1 = more active response, 0 = less active response; final model, using three-tier intervention IV; values shown are β, log coefficient. Sex: 1 = boy, 0 = girl; SES = self-reported free lunch recipient: 1 = yes, 0 = no. Other sample descriptives: current students are a small sample size of n=*20 compared to* n=*86 past intervention participants.*
** p =< .05, ** p =< .01, [NS] = Non-significant, [I] = Influential p =< .10, NA = Not Applicable.*
odds ratio: [95% CI=confidence interval: LL=lower limit; UL=upper limit].

The boxplots in Figure 12 illustrate the findings from the logistic regression, showing that the intervention has a material impact on physical activity attitude, for the first three years after the intervention. As noted earlier, the sample size for year 4.5 is too small for a reliable comparison.

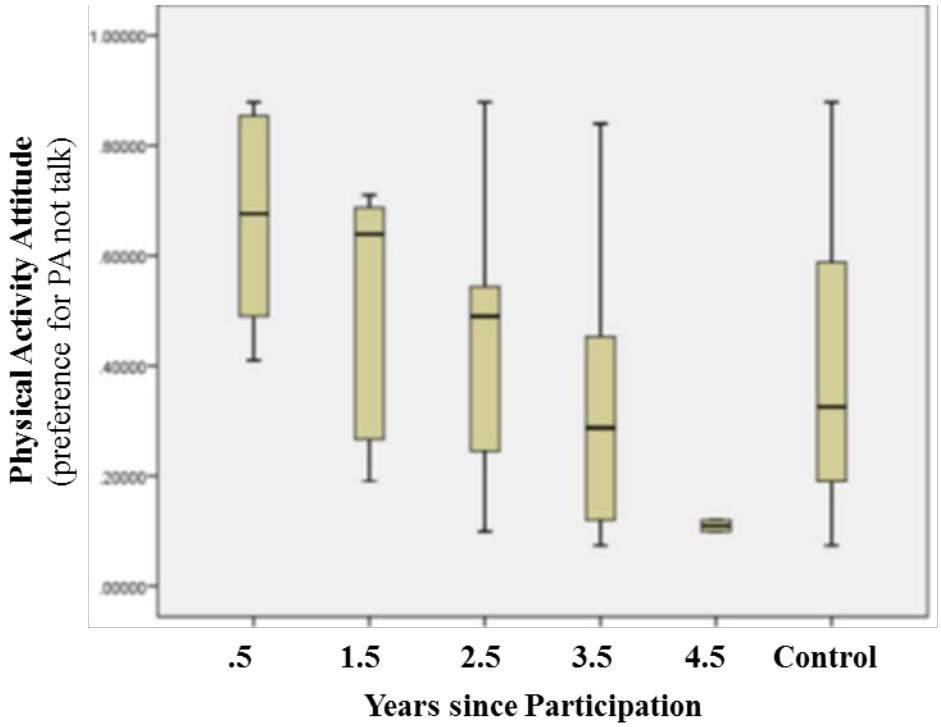

Figure 12. Physical activity attitude by years since intervention participation.

These findings are further exhibited by Figure 13 where data from control groups, current participants, and past participants are grouped in individual columns. Students in the control group are in the left column, past participants in the middle column and current participants in the right column. These results support the more detailed years-since-participation graph (Figure 12). They show a major intervention effect in the year of intervention, though a lower long-term impact post-intervention. Nevertheless, the higher past-participant median compared to control students reinforces the findings shown in Figure

12, indicating some persistence of healthy PA attitude learning in the initial years after participation.

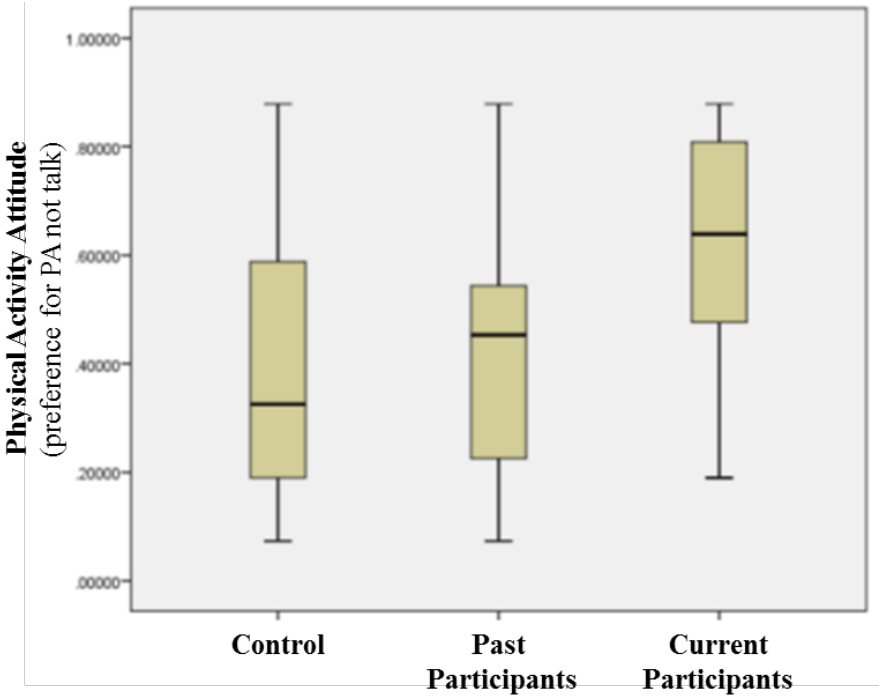

Figure 13. Physical activity attitude by control, past, & current participation.

The panel plots in Figure 14 provide additional details regarding gender-related differences. In general, boys reported a much stronger preference to engage in PA than girls. Nevertheless, intervention girls reported a higher preference to run at recess compared to girls in the control group up to about 3 years post-intervention. This is supported by the higher relative impact of the intervention on girls indicated by the regression interaction analysis, noted above.

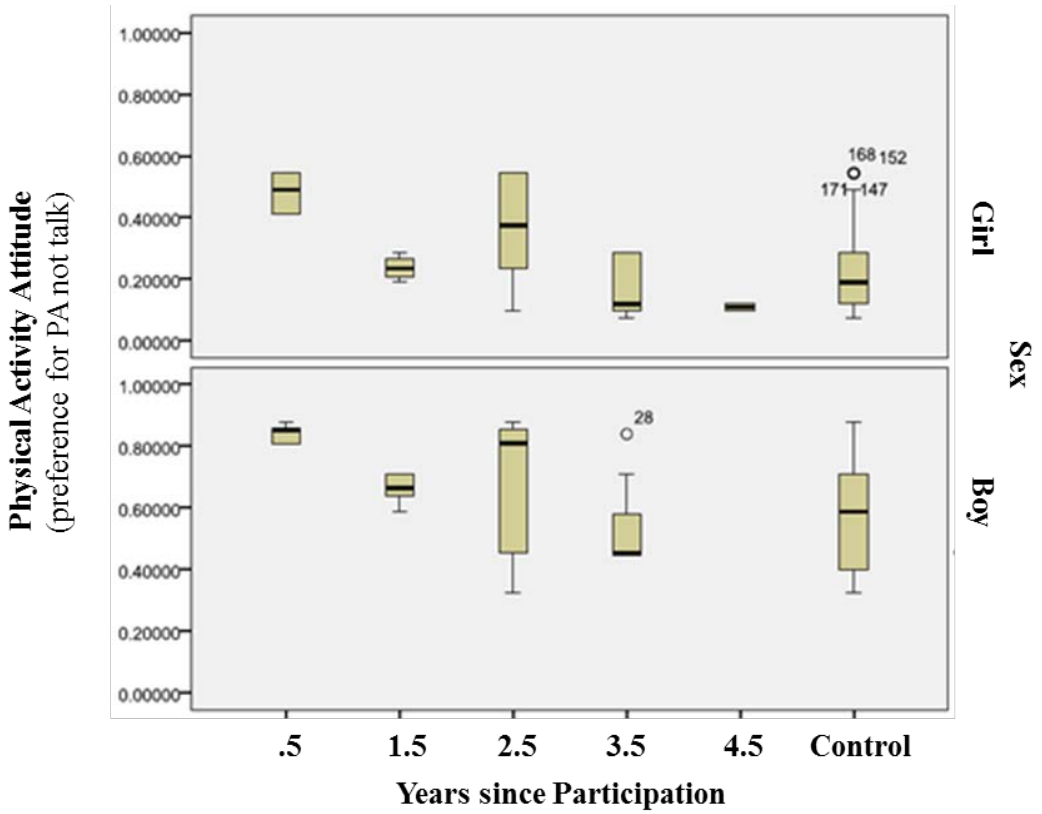

Figure 14. Physical activity attitude by sex & years since intervention participation.

When all of the results are examined, intervention *PA* attitude learning seems to have been more resilient than intervention *nutrition* attitude.

A second survey question related to PA attitude asked students whether after-school they would prefer to watch TV, or to play a game outdoors running with friends. Given this choice, a majority of both control and intervention students preferred to be physically active with friends. Unfortunately, this question could not be used in the regression or boxplot analysis because it was judged to be ambiguous. In contrast, the principal PA attitude question addressed above, about students' preferred choice of activity with friends at recess, did not force students to choose between doing something with vs. without friends. Both

choices in the principal *PA attitude* question used as the dependent variable in the above regression analysis included friends, thereby making the social element more neutral.

Physical Activity Behavior

The intervention's positive impact on physical activity outcomes continued with PA behavior, and healthier PA behavior seemed to persist for several years after participation in the intervention. As with PA attitude, gender played a major role in PA outcomes. Participant girls benefited materially, in a statistically significant manner, from the intervention, when compared to control girls.

Two approaches were taken to measuring physical activity behavior. In order to help maximize validity of results (M. Rahn, personal communications, 2012-2013), the two extremes of high and low PA were examined, as defined below. This approach helped to clarify true differences in PA behavior between groups.

To measure high physical activity behavior, the student's self-reported degree of running around at recess was used as the independent variable. If the student chose the more active PA responses of running all the time or a lot at recess, the student was coded as 1 as the outcome, otherwise the student was coded as 0 as the reference category. Respondent sample size (*n)* was 234 in the model using the standard intervention variable, and including both boys and girls. All models shown were significant at $p < .001$, indicating that the models were performing better than the intercept model and fit the data; -2LL for the final model was 273.448, with Nagelkerke R^2 of 0.295.

The *PA behavior* results indicated, as with *PA attitude*, that physical activity declined significantly ($p = .000$) by 61% (1 - 0.394 = .606) from the previous grade as the student moved into each higher grade ($\beta = -0.932$, odds ratio = 0.394). In other words, as the

students advanced to the next grade, the odds that students preferred to run most or all the time at recess were more than 2.5 times lower (1 / 0.394 = 2.54) than the year before. Similarly to *PA attitude*, the chances of boys being highly physically active was significantly ($p < .001$) and substantially higher than girls (β = 2.042, odds ratio = 7.703). In addition, Hispanic students reported significantly ($p = .033$) lower *high PA* levels, (i.e., they were much less likely to be very physically active), with Hispanic students' probability of having high PA approximately 51% (β = -0.716, odds ratio = 0.488) lower than for non-Hispanics. Intervention students were significantly ($p = .028$) more likely to report higher PA behavior. In general, for all intervention students as a whole, they were 2.22x more likely to claim high PA behavior (β = 0.798, odds ratio = 2.221) than control students.

Table 15

High PA Behavior Outcome (standard intervention IV)

logistic regression with independent variables; n=234; -2LL = 226.548; R^2 = .330; omnibus test p = .000; full model

Variable	*β*	*p*	Odds ratio	95% CI	
				LL	UL
Intercept	4.323	.010*	75.432	2.847	1998.686
Grade	-0.932	.000**	0.394	0.248	0.625
Sex	2.042	.000**	7.703	3.705	16.015
SES	0.589	.131 [NS]	1.802	0.839	3.870
Hispanic	-0.947	.011*	0.388	0.187	0.804
Intervention	0.798	.028*	2.221	1.090	4.524

Notes: High PA behavior: 1 = more active response, 0 = less active response; final model, using standard intervention IV values; shown are β, log coefficient. Sex: 1 = boy, 0 = girl; SES = self-reported free lunch recipient: 1 = yes, 0 = no. Other sample descriptives: 72 gave high PA responses, while 162 gave low PA responses; 97 respondents had participated in the intervention, while 137 were in the control group.
** p =< .05, ** p =< .01, [NS] = Non-significant, [I] = Influential p =< .10, NA = Not Applicable.*
odds ratio: [95% CI=confidence interval: LL=lower limit; UL=upper limit]

As shown in Table 16 below, students currently participating in the intervention were 9.66 times more likely to declare having high PA than control students (β = 2.268, odds ratio = 9.662, *p* = .002). This compared to non-significant outcomes for past intervention students as a group.

Table 16

High PA Behavior Outcome (three-tier intervention IV)

logistic regression with independent variables; n=281; -2LL = 329.290; R^2 = .293; *omnibus test p = .000; reduced model*

Variable	β	*p*	Odds ratio	95% CI	
				LL	UL
Intercept	4.119	.012*	61.526	2.483	1524.454
Grade	-0.850	.000**	0.427	0.271	0.673
Sex	1.789	.000**	5.982	3.125	11.450
Hispanic	-0.457	.141	0.633	0.345	1.163
Intervention					
Currently participating	2.268	.002**	9.662	2.283	40.886
Participated in past	0.357	.298	1.430	0.729	2.804

Notes: High PA behavior: 1 = more active response, 0 = less active response; final model, using three-tier intervention IV; values shown are β, log coefficient. Sex: 1 = boy, 0 = girl; SES = self-reported free lunch recipient: 1 = yes, 0 = no. Other sample descriptives: current students are a small sample size of n=*20 compared to* n=*86 past intervention participants.*
** p =< .05, ** p =< .01, [NS] = Non-significant, [I] = Influential p =< .10, NA = Not Applicable. odds ratio: [95% CI=confidence interval: LL=lower limit; UL=upper limit]*

A review of high PA behavior among only sixth-grade students supported the above results, as seen below in Table 17. Currently participating sixth-grade students had significantly higher odds of having high PA behavior than sixth-grade control students (β = 1.965, odds ratio = 7.133, *p* = .016), in spite of the low sample size (*n* = 20 current participants; *n* = 19 control students). Among this cohort, which had a particularly high percentage of low SES students, SES was not significant and was removed from the final model.

Table 17

High PA Behavior Outcome, sixth-grade only (three-tier intervention IV)

logistic regression with independent variables; n=68; -2LL = 96.986; R^2 = .243; *omnibus test p = .001; reduced model.*

Variable	β	*p*	Odds ratio	95% CI	
				LL	UL
Intercept	-0.512	.408	0.599	0.178	2.018
Sex	1.251	.041*	3.494	1.050	11.626
Hispanic	-0.548	.350	0.578	0.183	1.824
Intervention					
Currently participating	1.965	.016*	7.133	1.443	35.257
Participated in past	0.081	.902	1.084	0.299	3.932

Notes: High PA behavior: 1 = more active response, 0 = less active response; final model, using three-tier intervention IV; values shown are β, log coefficient. Sex: 1 = boy, 0 = girl; SES = self-reported free lunch recipient: 1 = yes, 0 = no. Other sample descriptives: sixth-grade students are a small sample size: n=*20 current participants compared to* n=*29 past participants, and* n = *19 control students in sixth-grade.*
** p =< .05, ** p =< .01, [NS] = Non-significant, [I] = Influential p =< .10, NA = Not Applicable. odds ratio: [95% CI=confidence interval: LL=lower limit; UL=upper limit].*

Figure 15 displays the findings that self-reported PA activity was higher for intervention students, as seen in the logistic regression model. Nevertheless, there is a significant drop as soon as students stop participating. The panel plots in Figure 16 provide additional details regarding gender-based differences in regard to high physical activity. Interestingly, as can be seen in the boxplot comparing boys' and girls' *high PA behavior*, a group of particularly active 2.5-years-ago intervention boys appears to have had a significant impact on the results, when comparing students who had participated in the past to control students who never participated; the decline in high PA behavior by the 2½-years-ago intervention students might have been even more substantial without these extremely active students. The pattern of higher PA by boys than girls continues, as expected. Also, intervention girls continue to show evidence of higher PA activity than control girls.

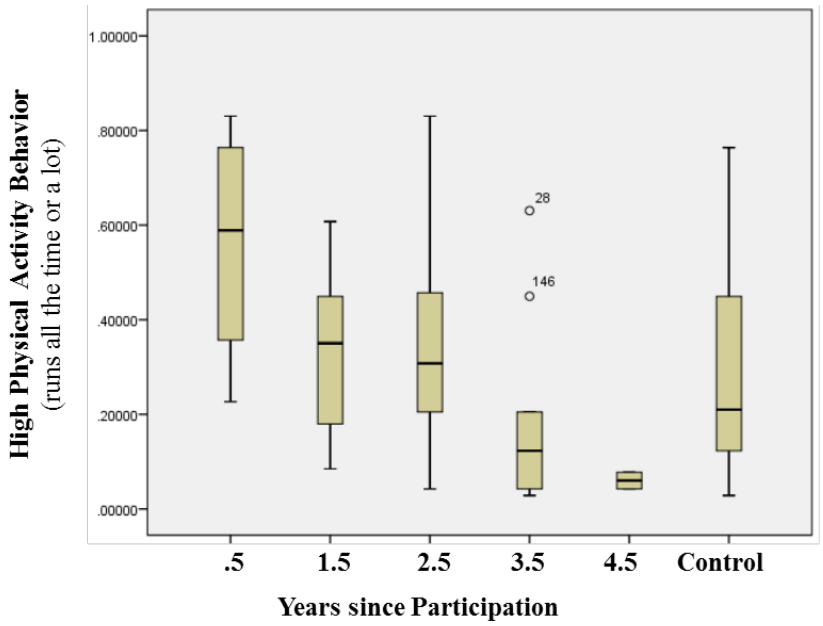

Figure 15. High physical activity behavior by years since intervention participation.

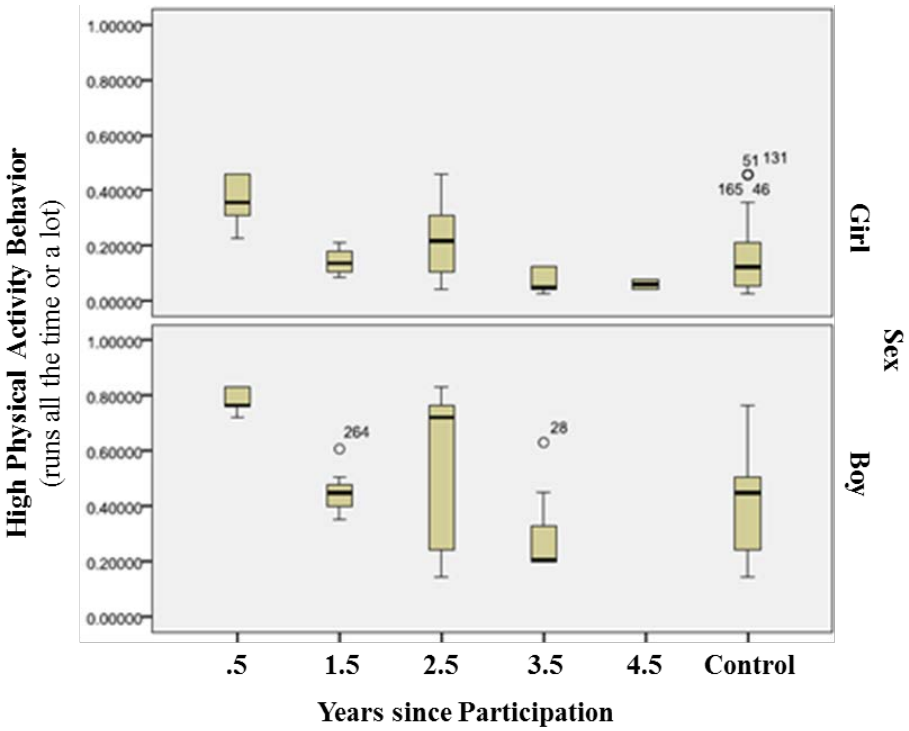

Figure 16. High physical activity behavior by sex & years since intervention participation.

In Figure 17, data from control groups, current participants, and past participants are grouped in individual columns, with control students in the left column, past participants in the middle column and current participants in the right column. These results support the more detailed years-since-participation information presented in Figure 15. They show a major intervention effect in the year of intervention, though a substantially lower long-term impact post-intervention for past participants as a whole. Nevertheless, the higher past-participant median compared to control students reinforces the earlier boxplot, showing some persistence of healthy PA attitude learning in the initial years after participation. There are a number of outliers among former intervention participants, who are particularly active.

In brief, the overall pattern of some long-term post-participation impact continues in the form of *high PA behavior*.

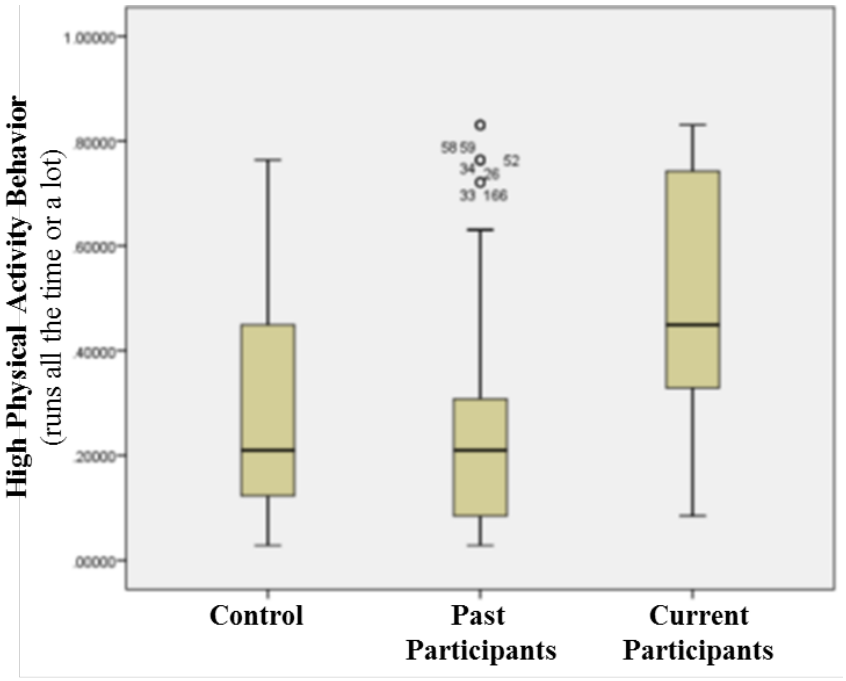

Figure 17. High physical activity behavior by control, past, & current participation.

We now turn to the other extreme of low physical activity behavior. The outcome results reinforce what *high PA behavior* indicated. Intervention students report less low physical activity than control students. Results are significant for intervention students as a whole, and they align in their implications with *high PA behavior*.

To measure low physical activity behavior, the student's self-reported degree of running around at recess was used as the independent variable. If the student chose the less active PA responses of running little or not at all, the student's response was coded as 1 as the outcome, otherwise the student was coded as 0 as the reference category. Respondent sample size (*n)* was 234 in the model using the standard intervention variable, and including both boys and girls. All models shown were significant at $p < .001$, indicating that the models were performing better than the intercept model and fit the data; -2LL for the final principal models was 226.548, and Nagelkerke R^2 was 0.330.

The results for low PA corroborated the outcomes for high PA, as shown in Table 18 below. Students in higher grades say that they have significantly lower PA ($\beta = 0.810$, odds ratio = 2.248, $p < .001$), with an average 2.25 times higher likelihood of declaring low PA behavior for each unit increase in grades. Boys are significantly less likely to have low PA than girls ($\beta = -1.449$, odds ratio = 0.235, $p = .000$), with a 76.5% less chance of reporting low PA behavior at recess. In other words, the odds of a boy reporting high PA activity at recess were 4.26 times the odds that he would report low PA. Hispanic students appear significantly more likely to be less active ($\beta = 0.588$, $p = .075$, odds ratio = 1.80), though the significance level is lower than with other independent variables. The odds that Hispanic students would report low PA at recess is 1.8 times greater than their non-Hispanic peers. Intervention students as a group are 54% less likely to have low PA than control students

(β = -0.786, *p* = .016, odds ratio = 0.456). In other words, the odds that intervention students would not report low physical activity at recess is more than twice (1/0.456 = 2.19) the odds that they would report low physical activity.

Table 18

Low PA Behavior Outcome (standard intervention IV)

logistic regression with independent variables; n=234; -2LL = 226.548; R^2 = .330; omnibus test p = .000; full model

Variable	β	*p*	Odds ratio	95% CI	
				LL	UL
Intercept	-4.867	.001**	0.008	0.000	0.143
Grade	0.810	.000**	2.248	1.501	3.367
Sex	-1.449	.000**	0.235	0.125	0.440
SES	-0.747	.031*	0.474	0.240	0.934
Hispanic	0.588	.075	1.800	0.943	3.434
Intervention	-0.786	.016*	0.456	0.241	0.863

Notes: Low PA behavior: 1 = less active response, 0 = more active response; final model, using standard intervention IV values; shown are β, log coefficient. Sex: 1 = boy, 0 = girl; SES = self-reported free lunch recipient: 1 = yes, 0 = no. > 1 odds ratio effect size is less healthy, <1 is healthier. Other sample descriptives: 102 gave a low PA response, while 132 gave a non-low PA response.; 97 respondents had participated in the intervention, while 137 were in the control group.
** p =< .05, ** p =< .01, [NS] = Non-significant, [I] = Influential p =< .10, NA = Not Applicable.*
odds ratio: [95% CI=confidence interval: LL=lower limit; UL=upper limit]

Differences between low physical activity scores between current participants (β = -1.335, odds ratio = 0.263, *p* = .102) and past intervention participants (β = -0.429, odds ratio = 0.651, *p* = .150) were not significant. Although mean scores were better for intervention participants, an effect of intervention cannot be assumed. It is possible that increased sample sizes for current participants would refine these results.

Table 12

Low PA Behavior Outcome (three-tier intervention IV)

logistic regression with independent variables; n=281; -2LL = 269.863; R^2 = .330; *omnibus test p = .000; full model*

Variable	β	*p*	Odds ratio	95% CI	
				LL	UL
Intercept	-4.942	.001**	0.007	0.000	0.119
Grade	0.797	.000**	2.218	1.508	3.264
Sex	-1.177	.000**	0.308	0.179	0.530
SES	-0.593	.051*	0.553	0.305	1.002
Hispanic	0.230	.423	1.259	0.716	2.213
Intervention					
Currently participating	-1.335	.102	0.263	0.053	1.301
Participated in past	-0.429	.150	0.651	0.363	1.168

Notes: Low PA behavior: 1 = less active response, 0 = more active response; final model, using three-tier intervention IV; values shown are β, log coefficient. Sex: 1 = boy, 0 = girl; SES = self-reported free lunch recipient: 1 = yes, 0 = no. Other sample descriptives: current students are a small sample size of n=*20 compared to* n=*86 past intervention participants.*
** p =< .05, ** p =< .01, [NS] = Non-significant, [I] = Influential p =< .10, NA = Not Applicable. odds ratio: [95% CI=confidence interval: LL=lower limit; UL=upper limit]*

Qualitative Results

Student Comments

Qualitative responses by students to open-ended survey questions helped to add support and color to and improve understanding of quantitative responses. It has already been noted how intervention girls had substantially healthier PA attitude and behavior compared to control girls. Comparing control to intervention girls' responses to questions about their nutrition and PA practices, in particular, added some important support and nuances to the data, and made it come alive.

For example, students were asked to "describe briefly why eating and drinking healthy things is important." Boys tended to focus on how good nutrition keeps them healthy and strong, and also gives them energy and nutrients including vitamins. Girls in general also talked about how healthy food and drink helped them to stay healthy and gave them energy. A number of girls also talked about how healthy nutrition supplied nutrients including vitamins, and how good nutrition helped them avoid becoming overweight and "getting fat." Girl intervention participants' comments included the following: "It is important because if you eat junk food a lot it's not healthy and you will become overweight." "Because its (*sic*) important for your body and it helps prevent sickness." Girl nonparticipants: "If you don't choose healthy choices then you will become overweight." "It's important because it has more proteins, vitamins and nutricional (*sic*) value." "To be able to keep a good body figure and be healthy." Interestingly, several girls who had not participated in Operation Tone-Up specifically mentioned avoiding diabetes, while girls who had participated in OTU talked more generally about avoiding sickness. Discussing diabetes and disease is not a major component of Operation Tone-Up, though diabetes would be expected to affect unhealthy families more than healthy ones. Also, former OTU participants mentioned more about how healthy nutrition would help them to live longer.

Students were also asked what type of physical activity they had most recently participated in, not counting PE. Interestingly, intervention girls tended to declare that they had engaged in more vigorous physical activities, including running and soccer, while control girls often mentioned walking, swimming (not described), dancing and softball more than participants, though a few mentioned basketball. These qualitative responses appeared to support previously discussed evidence from students' responses to questions about what they

did at recess: OTU participants—particularly girls—said they significantly preferred to run more than nonparticipants. When reviewed by grade level, girls' responses seemed to reflect the quantitative data as well. There appeared to be a trend toward less rigorous, less aerobic physical activity, particularly as non-OTU-participant girl students moved into later grades. Basketball and bicycling become less prominent, while softball, volleyball, and walking become more prominent over time, though some eighth graders do mention running as well. On the other hand, some former OTU participant girls mention both basketball and soccer prominently, even in Grade 8.

Finally, students were asked to "describe briefly why physical activity is important." Boys spoke about how PA helps them to be fit and stay in shape, as well as helping them to stay healthy, build muscles and be strong, and not get fat. Girls also mentioned being fit and staying in shape and healthy, but spoke more than boys about body proportions and weight. However, girls' responses to this question were not as varied as for the other two questions, and did not add as much to understanding possible differences between intervention and control students. Girl intervention participants' comments included the following: "Because it gets your brain going and your heart pumping." "So you don't become fat." Girl nonparticipants: "It's important because it helps to keep you active and healthy." "It gives you energy and makes you physically active, keeps your body in shape."

Teacher Interviews

Teachers' comments during interviews also provided interesting insights. One long-serving PE teacher covering all grades felt that virtually all school-based nutrition learning, which students had received at the teacher's elementary school, had come through Operation Tone-Up, in spite of the school district's standard nutrition curriculum. In addition, this

teacher thought that about 30-40% of students' exercise knowledge and behavior had come through OTU, and that other PE instruction had provided the rest. Another long-serving PE teacher at a different elementary school in the same district agreed concerning the overwhelming importance of Operation Tone-Up for providing nutrition education at the elementary school. But this teacher also felt that OTU had had an even more important impact on exercise knowledge and behavior than the first teacher had thought. This teacher also felt that Operation Tone-Up had had an impact on students' families.

Related to this, some teachers interviewed at elementary schools, which had not implemented Operation Tone-Up, did not have a high opinion of their school's and district's standard elementary school nutrition and exercise education. These comments, coupled with the survey results for nutrition behavior, imply that the school district is teaching nutrition knowledge much more effectively than nutrition and PA attitudes and behaviors.

Two teachers at two different elementary schools did highlight the value of offering a nutritious breakfast in the classroom to all students, which seemed more important to them than the standard non-intervention nutrition learning which the school provided. Elementary School A even reported receiving a grant to allow students to try out different kinds of fruit in class (personnel of Phoenix Area School District, personal communications, 2011-2013). This may have boosted fruit consumption numbers for current intervention participants relative to control students. (I did not have information on which other schools had similar programs.) While another teacher at the same school seemed enthusiastic about a particular exercise-related program, which the school had introduced, the teacher was not able to assess impact, and seemed discouraged that parents were not doing enough to encourage their children to exercise. Several teachers mentioned that it was hard to get some other teachers

interested in spending scarce classroom time on nutrition and fitness education, even though the interviewed teachers stated that they believed in such education themselves.

Other Results

Duration of Participation

Regression models did not indicate as large an impact on nutrition and PA outcomes among middle schoolers, based on the cumulative number of years they had participated in the intervention. The recency of participation seemed more important than the number of years of participation, in terms of the long-term impact among middle schoolers post-intervention. While many past participants had participated for 2-3 years in the intervention, most of the participants surveyed had not participated in the program during the previous 2.5-3.5 years. Considering both of these influences alongside each other—duration of participation and time since participation—is revealing. Unreinforced stimuli occurring 2.5-6.5 years ago constitute a considerable gap of time and curricular dis-continuity for 12 to 14-year-old children, in spite of the duration of previous participation (Johnson-Askew et al., 2009; G. S. Reynolds, 1968). It appears that the effects of time without reinforcement or continuity lead to relatively rapid declines in knowledge, attitudes, and behaviors, in spite of repetition of the program in the relatively distant past. Therefore, detailed analysis was focused on intervention participation and years-since-participation, rather than number-of-years-of-participation.

Table 20

Number of Years During which Intervention Participants Received Intervention

	Intervention							Control
Years of Participation	.5	1.0	1.5	2.0	2.5	3.0	4.0	NA
n	6	35	5	59	14	12	1	238
%	1.6%	9.5%	1.4%	15.9%	3.8%	3.2%	0.3%	64.3%

Self-Reported Importance of Nutrition and PA

Both control and intervention students assigned similar importance to good eating. Intervention students assigned somewhat higher importance than control students to physical activity. The latter differences are in line with the relatively higher effect size impact that the intervention had on physical activity compared to on nutrition. However, as seen in students' responses to other survey questions, considering nutrition and exercise important appears to have little impact on students' attitudes and behaviors, especially among control students.

Table 21

Stated Importance of Nutrition & PA

	Not important	A little important	Somewhat important	Important	Very important
Nutrition					
Control	2%	1%	4%	31%	63%
Intervention	1%	0%	5%	29%	65%
PA					
Control	1%	2%	10%	34%	53%
Intervention	1%	0%	3%	38%	58%

Self-Evaluated Healthiness of Behavior vs. Peers

One interesting set of results was in response to the two questions, which asked students to compare their nutrition and PA habits to their fellow students. A higher percentage of control students than intervention students assessed that their own habits in these areas were healthier than their peers. A relatively small percentage of students felt that their eating or PA habits were less healthy than their peers. These responses may help in assessing the impact of social desirability bias. They may also support students' responses on the healthiness of nutrition relative to PA.

Table 22

Self-Perceived Behavior Healthiness vs. Peers

	Less Healthy	About Same	More Healthy
Eat Healthier than Peers?			
Control	10%	50%	40%
Intervention	5%	60%	34%
Higher PA than Peers?			
Control	8%	46%	46%
Intervention	11%	50%	39%

Nutrition, PA, and Student Self-Perceived Academic Performance

Students' responses indicated that students perceive good nutrition and physical activity as improving their academic performance. In response to the survey question, "How well do you do in class when you eat healthy food, compared to when you do not eat healthy food?," 39% of control students and 52% of intervention students said that they do better

with healthy food, and only 2% of both control and intervention students said they did worse. In response to the question, "How do you do in class and with your school work when you have been active, compared to when you are not active?," 37% of control students and 57% of intervention students said that they do better when they have been active, while only 6% of control and 2% of intervention students said they did worse. (Other response options were either "did about the same" or "don't know"; about one-third of students had missing data including "don't know," which are not included in the above valid percentages. Even if all missing data are added into "I do about the same," 29% of students say they do better in school by eating healthily, and 31% say they do better in school by being physically active.)

Table 23

How do you do in class when you eat healthy food?

	I do Worse	I do About Same	I do Better
Nutrition			
Control	2%	59%	39%
Intervention	2%	46%	52%
Average	2%	53%	45%

Table 24

How do you do in class when you have been active?

	I do Worse	I do About Same	I do Better
Physical Activity			
Control	6%	57%	37%
Intervention	2%	41%	57%
Average	4%	49%	47%

Other Variables and Responses

Other independent and dependent variables besides those examined above did not appear to offer sufficient statistical significance, clarity, and/or insights to analyze further, and so are not included in the analysis.

Results Summary

This study's results support the hypothesis that Operation Tone-Up is an effective health intervention short-term, as well as over a period of up to several years after implementation. Nevertheless, as hypothesized, the impact of the intervention declines over the first several years after participation. Within 3-4 years after intervention participation, there seems to be little difference in nutrition or physical activity knowledge, attitudes, or behaviors between control and intervention students and no statistically significant difference. Indeed, broadly speaking, the statistical significance of the difference appears to end during the second to third year after intervention, even though a non-significant difference may persist for longer for some dependent variables.

Boys seem to learn the most about nutrition from the intervention, in terms of statistically significant, broader and more accurate knowledge of key nutrients and the metabolism physiological mechanism, which are taught as part of the Operation Tone-Up. This knowledge tends to erode over time, yet students' nutrition knowledge from other sources—apparently from middle school instruction, in particular—appears to increase, ending with very little difference between control and intervention boys' nutrition knowledge 2 years after the intervention. Nutrition attitude appears to be healthier among intervention boys and girls, but not statistically significantly so at $p < .05$ for the groups as a whole. Nutrition behavior appears healthier among intervention students, both students currently

participating and those who participated in the past, though nutrition behavior and other nutrition-related differences are not as clear-cut as for physical activity.

The intervention had a material and often statistically significant impact on students' PA attitude and behavior. This impact was particularly salient for adolescent girls, given their propensity to dramatically reduce PA in their teen years, as discussed in the literature review. Among girls, the intervention seemed to have a material impact on their nutrition behavior and PA attitude and behavior for several years. Girls in the intervention group report that they are more likely to spend time running during recess rather than with friends, and their level of activity appears to be more rigorous, though this difference seems to disappear in the third year after intervention. These results for girls were supported by qualitative results from students' responses to open-ended questions about their nutrition and PA habits.

In addition, students report self-awareness of the impact of nutrition and physical activity on their academic performance. Both control and intervention students perceive that good nutrition and being active help them to do better in class. These self-perceptions support the growing body of evidence that rigorous physical activity can improve academic performance, even though it utilizes school time otherwise employed for academic instruction on core subjects.

CHAPTER FIVE: DISCUSSION AND CONCLUSIONS

The Operation Tone-Up intervention had a substantial impact on students' nutrition and physical activity, both during the intervention and generally for several years afterward. As predicted, the impact diminishes over time, and after several years the difference between control and intervention students is generally not perceptible. Curriculum theory provides a powerful lens for making sense of these results. It proposes that we cannot expect prolonged learning and habit change, without adequate curricular continuity. What is more, curriculum theory coupled with a review of best practices indicate that, ultimately, it is essential that health education be demanding, rigorous, and integrated into the curriculum over the long-term, in order for health education to help to substantially improve healthy behaviors later in life. On the bright side, growing evidence for a causal link between nutrition and PA and academic performance provides an opportunity to persuade education and political leaders to invest more in effective health education. I will first discuss study conclusions by dependent variable, then proceed to more general considerations and overall conclusions and implications.

Discussion

Nutrition Knowledge

Nutrition knowledge, unlike other nutrition and PA outcomes, did not fade away for middle school students surveyed, as they aged and moved up by grade. This may be happening as a result of students learning nutrition-related facts through the standard school curriculum, as they continue in middle school. The curriculum director for the school district confirmed that nutrition knowledge similar to that covered by Operation Tone-Up is covered

at least to some extent in the district's standard Grades 3-5 and particularly Grades 6-8 curriculum (Curriculum Director of School District, personal communications, 2013). This seems to indicate that district middle schools are to some extent successfully teaching nutrition knowledge. Related to this, in contrast to many other dependent variables, the independent variable of *grade* did not appear to have a substantial influence on *nutrition knowledge*.

This could be a result of conflicting trends, as touched on above: The apparent tendency by adolescent middle school students to lose intervention-learned knowledge, and perhaps to not focus on nutrition as they move into adolescence in higher grades, is seemingly being counter-acted to some extent by ongoing school-based nutrition education. *Nutrition knowledge* also differs as an outcome from other results measured, in that learning the roles of protein, carbohydrates, and metabolism is somewhat similar to learning other academic subjects, whereas learning healthy nutrition or PA attitudes or behaviors involves different types of learning. Schools may be more comfortable and effective in teaching knowledge rather than attitudes and behaviors (Page & Page, 2010). At any rate, given the decline in other nutrition and PA outcomes surveyed, middle schools are failing to alleviate worsening health habits of adolescents. Knowledge, unfortunately but not unexpectedly, does not necessarily lead to action.

The ongoing importance of socioeconomic status in affecting nutrition points to the special efforts which will be needed to substantially raise nutrition knowledge, attitudes and behaviors among lower income populations.

Even though the β for current intervention students' nutrition knowledge is not statistically significant, the implication from other dependent variables studied, is that the

intervention is likely to have an even higher impact on current participants' nutrition knowledge. It appears that the small current participant sample size simply did not allow the study to capture the true impact statistically. In addition, as noted in Chapter 3, current students did not participate in the standard Operation Tone-Up intervention, but in a limited version of it, and may not have had typical intervention exposure to nutrition knowledge information

The type of nutrition knowledge surveyed may go some way to explaining the gender differences in the results. The survey questions asked about the roles of protein, carbohydrates, and metabolism, which are related to strength and energy. Strength and energy may well be of more interest to boys at this age than to girls, and therefore the learning about them may be more readily absorbed and recalled by boys. A significant interaction (p = .030) between SES and gender indicated that high SES boys had 6 times greater odds of correct nutrition knowledge than their female high SES peers, after controlling for intervention. More attention must be paid by educators and interventions such as Operation Tone-Up to finding personally motivating ways to relate key nutrition information to areas of interest to girls.

Nutrition Attitude

While nutrition knowledge did not fade as students moved up through grades, other aspects of nutrition and PA did. The student's grade level captures both academic learning and age/development level. When it comes to nutrition attitude, nutrition-related learning at school seems to be more than counteracted by other age-and-stage development or other influences, reflected by grade level. Unfortunately, there is a consistent pattern of declining nutrition and PA attitude and behavior, as students age and move into higher grades. Any

nutrition knowledge that they are learning through the standard school curriculum does not compensate for the apparent effects of development, family, marketing, and other factors, in terms of students' nutrition and PA outlook and practices.

Although intervention impact on nutrition attitude is not statistically significant, regression results and boxplots indicate positive intervention influence on nutrition attitude.

It appears that substantial efforts are required to counteract poor eating, drinking, and exercise habits in adolescence, in addition to countering other factors steering middle school students in unhealthy directions. Fortunately, the generally large effect size of Operation Tone-Up in the year of intervention indicates that rigorous health education could help to alleviate trends toward unhealthy living among these elementary and middle school students. The rigor would need to be maintained, while the materials and approaches are adjusted for rapidly changing student psychological and social development.

Nutrition Behavior

The intervention also had an impact on students' nutrition behavior. The impact was somewhat clouded by the role of grade level. Yet as with *nutrition knowledge* and *nutrition attitude*, there appeared to be an association between the intervention and *nutrition behavior*. The study results reinforced the literature that socioeconomic status has a powerful impact on nutrition behavior. Low SES is a predictor of unhealthy eating and drinking behavior, just as it was for nutrition knowledge. There is some indication, though, that effective interventions may help alleviate this tendency. As with other nutrition variables, the combination of regression and boxplot results imply substantial and statistically significant intervention impact on the healthiness of nutrition behavior, though impact diminishes over the years due to inadequate reinforcement.

It appears, though, that there is room to improve the intervention, in order to increase intervention nutrition-related effect sizes, which are far below PA behavior effect sizes.

Physical Activity Attitudes and Behavior

The study showed that entering adolescence need not condemn teenagers to inactivity. This is particularly important for girls, who tend to become much more sedentary than boys in middle school, as seen from the literature review.

This study's results imply two key things in regard to the physical activity of the middle schoolers surveyed. First, the particularly high PA of current intervention participants, while it was only studied among sixth-graders, gives hope that continuing, developmentally evolved, OTU-style, fun, yet rigorous PA programs in seventh and eighth grade may help to maintain PA at much higher levels than normal, and blunt the tendency for PA to decline. Second, if effective PA interventions are conducted in sixth-grade, there is more likely to be some important persistence of healthier PA attitudes and practices later in middle school, on which middle school PE programs could build. For example, recent intervention participation in vigorous aerobic exercise in elementary school may make it easier for middle school PE teachers to engage students in vigorous aerobic exercise, too.

Along these lines, when the three-tier intervention variable was used, only currently participating students had a statistically significantly (p = .011) healthier physical activity attitude than control students; nevertheless, the odds ratio of 15.891 was impressive, implying a much higher chance of having a healthier PA attitude among intervention students, even though both boy and girls were included. What is more, substantially higher PA attitude odds ratios among currently participating students imply that intervention participation could perhaps far eclipse the negative effect (β = -0.852, odds ratio = 0.427,

p = .000) of higher grade, that is, later developmental levels, if the intervention or similar though developmentally evolved approaches were continued in higher grades. (Socioeconomic status is generally less influential in PA than grade/developmental level and gender, in contrast to nutrition outcomes, with the exception of low PA outcomes.)

Emphasizing the importance of considering developmental influences, a majority of both control and intervention students preferred to be physically active with friends, rather than to watch TV after school. This may give some indication of the value of factoring in social elements, when considering curriculum to improve middle schoolers' PA. Likewise, it also gives hope that health and fitness educators should be able to address developmental stage characteristics, even leveraging teenagers' social tendencies, to improve effectiveness, rather than seeing adolescence as only a negative.

Nutrition Compared to PA Effects

While the intervention PA impact faded over time, it did not, generally speaking, appear to do so as quickly as with nutrition outcomes. Indeed, effect sizes for physical activity were generally larger than for nutrition. It could be that the physical activity portion of the intervention is more powerful than the nutrition portion. It could also be that the nutrition knowledge component of the middle school curriculum not only boosted nutrition knowledge scores of students, as conjectured earlier, but may also have had some positive spill-over in improving control students' nutrition attitude and behavior, while not materially impacting their physical activity. Either or both of these factors, or other ones, may have contributed to less differences between control and intervention students in nutrition than PA. In addition, nutrition was assigned somewhat greater importance than physical activity by

both groups, which may relate to how nutrition is positioned by the middle school curriculum and taught compared to PE.

At any rate, there is room for substantial improvement in nutrition health education generally. In addition, the Operation Tone-Up intervention may benefit from starting to measure nutrition attitude and nutrition behavior outcomes, in addition to nutrition knowledge, which it already measures pre- and post-intervention. A greater focus on nutrition attitude and behavior in the intervention design may improve nutrition-related outcomes more broadly among participants.

Qualitative Responses

The qualitative results appeared to support the quantitative results, particularly regarding girls' nutrition and physical activity. Girls in the intervention group tended to mention more vigorous PA than girls in the control group. Nevertheless, there also appeared to be a tendency for girls generally to mention less vigorous physical activities, as their grade level increased. The reasons for students' responses were unclear, but is it possible that intervention students had found that they felt healthier as a result of the intervention, and had developed and internalized greater self-awareness and higher expectations for themselves? After all, intervention students' quantitative responses indicate that they had better nutrition and more physical activity. In addition, self-awareness of the role of nutrition and PA in how students feel was certainly a goal of the intervention, and this self-awareness may well have stayed embedded to some extent in a number of students over time. Higher nutrition-and-exercise-related self-awareness among intervention students might also explain their greater beliefs in the links between nutrition, PA, and academic performance, even though this was not specifically discussed in intervention materials.

It is also possible that OTU teachers talked about the link between good nutrition and preventing sickness, even though this is not explicitly addressed in OTU (personnel of Phoenix Area School District, personal communications, 2011-2013). If so, this may explain why intervention students seemed to mention links between nutrition and sickness more. In addition, Operation Tone-Up tries to demonstrate to students the linkage between nutrition and exercise, including how good nutrition is important in order to have energy to exercise hard. The intervention also emphasizes the importance of building physical strength. Indeed, former OTU participants seemed to talk more in their qualitative responses about how healthy nutrition gives them energy and helps them to be stronger.

These factors may have contributed in some way to intervention students' qualitative responses, though students' open-ended question responses should not be overemphasized.

Stated Importance of Nutrition and PA, Social Desirability Bias, and Actual Attitude & Behavior

Paradoxically, the apparent tendency of intervention students to rate their own behavior less favorably than control students, when comparing themselves to their peers, could also have occurred due to greater self-awareness and internalization stemming from the intervention, too. In other words, the intervention may have raised intervention students' consciousness and *self-consciousness* of the importance of good nutrition and exercise. Other survey results implied that the healthiness of intervention students' behavior had declined since they had participated in the intervention, yet some intervention students' expectations may have remained high enough, that they felt they were not behaving as healthily as they should. As a result, intervention students may have evaluated the relative healthiness of their own behavior more harshly than control students did.

At any rate, intervention students' apparently harsher self-evaluation may have to some extent counter-acted social desirability bias more effectively than for control students. This could in turn imply that intervention students' other responses were less inflated than control students, and that intervention students' nutrition and PA could have been even healthier relative to control students than indicated by the questionnaires. What is more, if this is correct, some intervention effect sizes could actually be larger than found from the surveys.

In addition, while both control and intervention students had similarly high ratings of the importance of good nutrition and physical activity, responses on their actual attitudes and behaviors indicated that intervention students' knowledge of the importance of nutrition and PA had been turned into real-life preferences and behavior more effectively than control students. In addition, intervention students' qualitative comments about their participation in more aerobic physical activities also helps to support the quantitative results. This calls to mind one control elementary school teacher's comment implicating the standard school nutrition knowledge-oriented curriculum, which did not seem to be improving nutrition attitudes or behaviors: "All the girls want to be skinny, but they don't have a healthy way to be skinny" (personnel of Phoenix Area School District, personal communications, 2012). In contrast, Operation Tone-Up had apparently made more progress in improving the healthiness of children's habits than the status quo.

Healthy Nutrition, PA, and Academic Performance

The study survey results show that both control and intervention students perceive a link between healthy nutrition, physical activity, and academic performance. Intervention

students have an even higher belief in the positive academic impact of nutrition and PA than control students. This may stem in part from the higher self-awareness of the personal physical impact of nutrition and PA on the students, which the intervention intends to develop (Tony Lamka, personal communications, 2010-2013). The high degree of rigor of the intervention may further enable this self-awareness to develop. Personally, several students who had been through the Operation Tone-Up intervention in another school district told me that their focus, attention, and grades had improved, and teachers confirmed that they felt that grades had improved due at least in part to the intervention (personnel and students of El Monte School District, personal communications, 2011-2012). Some of the video footage related to this anecdotal yet compelling evidence is viewable at the web site, www.operationtoneup.com.

Yet, as noted earlier, one of the key obstacles for schools to allocate more time for health education including CO prevention is teachers' and administrators' beliefs that time spent on health education, PE, and other non-core subjects will hurt academic performance. School leaders' greatest concern is typically to optimize academic performance, increasingly as measured by standardized test scores, which do not include health education-related metrics. So health education is seen as a potential distraction. Not only is it a lower priority, it is seen as endangering meeting higher priorities, and thus it is in constant danger of being minimized or eliminated. As noted earlier, as standardized test scores become increasingly included in school districts', principals', and teachers' performance evaluations, the pressure to focus only on tested "core" subjects grows.

Conclusions

I am just one scholar-practitioner involved in the massive and complex systems of education and public health. This study attempts to contribute to scholarly dialogue and real-world practice in limited but material ways, in the hopes that each of the many ongoing efforts to address childhood obesity and other life skills and health behavior issues will ultimately lead to key tipping points for positive social change. What conclusions have we reached through this study? I believe that there are several key conclusions, including broader implications when viewed in the context of the American social and political system:

1. Effective in-school curriculum-based programs can substantially improve healthy behavior, though long-term impact depends on ongoing reinforcement.
2. School-based health programs need to be accepted by educators and not just health professionals. In order to achieve this, these programs must utilize curriculum theory and demonstrate contributions to academic success, and they must ultimately be backed by inclusion in core curriculum standards and mandatory testing.
3. Our society must prioritize prevention and leverage our political, health care, education, tax, and insurance systems with more effective coalition-building and persuasion strategies to promote impactful policies and practices. The combined impact can help us to curb the long-standing chronic health conditions epidemic.

Let us review each conclusion with supporting comments:

1. Effective in-school curriculum-based programs can substantially improve healthy behavior, though long-term impact depends on ongoing reinforcement.

In order for programs to be effective, they must include both nutrition and physical activity, be rigorous, developmentally and gender-appropriate, behavioral outcomes-oriented, and sustained over time. For maximum impact, parents should be included. In order to truly change behavior later in life, an integrated long-term curricular perspective should be used. Enough is known now to introduce mandatory practices into schools, which can then be evolved over time.

Students who participated in Operation Tone-Up, especially more recently, have healthier nutrition and PA habits than control students. These differences make OTU and similar approaches worthy of considerably more analysis, and worthy of consideration to include in future CO prevention and healthy behavior education development strategies. Not only do intervention students have better nutrition and PA, but a number of effect sizes are large. Indeed, in many cases, the effect sizes appear substantial enough to make up for typical disadvantages for students from vulnerable populations, including girls, and children from lower income and Hispanic backgrounds.

What is more, this and other highly effective elementary school interventions may help many students to be healthier, as they move into a more sedentary adolescent developmental stage. Adolescent self-consciousness, socializing, and other factors can weigh on physical activity, yet some groundwork has been laid earlier through interventions, and some vigorous physical activities and healthier PA attitudes persist. Participation in developmentally appropriate, effective interventions could perhaps counter-balance the negative developmental effects at higher grade levels in adolescence. The potential to build on elementary school nutrition and PA learning appears promising. This is evidenced by material persistence of healthy attitudes and behaviors after elementary school among

intervention students now in middle school. Physical activity among former Operation Tone-Up participants does not drop immediately to peer levels in middle school, in spite of lack of maintenance and increasing developmental obstacles. On the other hand, intervention impact fades over time, as middle schools do not continue intervention learning. This decline is to be expected based on learning theory and behavioral and cognitive psychology, in general, as well as curriculum theory, in particular. Therefore, reinforcement must persist through curricular continuity, in order for healthy behavior to be maintained at a high level longer term.

The methods by which continuity is provided need to evolve to meet the social-cognitive developmental stage characteristics of adolescence (G. S. Reynolds, 1968; Schunk, 2012). For example, the Operation Tone-Up program currently attempts to cover Grades 3-6 with a single set of materials, and may be stretched thin developmentally. In addition, students participating for multiple years may become less engaged without greater variety and developmentally appropriate program enhancements. Accept The Challenge recognizes many of these issues, and intends to address them (Tony Lamka, personal communications, 2010-2013).

The data seem to indicate that it is more important for middle school students to have participated in OTU recently, even if only for a year or two, than to have participated for many years but further in the past. OTU can be considered a successful intervention during and for a period after implementation, based on two prior studies and this study's results. However, as learning and curriculum theory predict, this impact fades over time. So it is not surprising that it appears better to have participated in OTU recently, and less important to have participated in OTU in the more distant past even if over multiple years.

This may imply that school districts with limited schedules and budgets could possibly invest less in nutrition and fitness education in early elementary school than later in elementary and middle school, and instead focus more on Grades 4, 5, 6, and beyond, to get more "bang for the buck." Traditional recess and PE time could provide a combination of unstructured and structured play and physical skills development time in earlier elementary grades, then focus could shift increasingly to more structured aerobic exercise in late elementary school and beyond. This would lay some foundation for more advanced learning later. However, this tentative conclusion comes with a significant caveat. Curriculum theory indicates the value of having at least some foundational education in early years. This provides a basis for the continued spiral of more advanced learning later (Bruner, 1960/1977). Ideally, nutrition and fitness education would start early, in Grades 3-4 and before, and develop and intensify over time, particularly in Grades 5 and 6 and continuing into later grades. This provides significant behavioral and cognitive momentum entering adolescence. What is more, recent nutrition and exercise program participation in elementary school, when children are more open to instruction, may make it easier for middle school PE teachers to engage students in vigorous PA in students' adolescent years, in spite of potential adolescent resistance. Previous intervention participants may be less self-conscious of participating in demanding nutrition and exercise work, which echoes what they have done in recent years (Tony Lamka, personal communications, 2010-2012). At a minimum, any early in-school nutrition situations and physical activities, whether meals, snacks, recess, PE, and so forth, should be considered as part of and integrated into a very long-term curricular plan, as with other school subjects.

At any rate, whatever other nutrition and PA education are offered, teachers in both elementary and middle school grades should still consider having brief aerobic exercises before tests in earlier grades, in order to help students perform better (Hillman, 2010; Hillman et al., 2008; Hillman, Pontifex, & Themanson, 2009; Hillman, Pontifex, Raine, et al., 2009). These pre-test exercises may also help students to begin to "feel" and internalize the link between good nutrition, physical fitness and classroom performance (Tony Lamka, personal communications, 2010-2012). Resulting improvements in test results could also help build teacher and administrator support for more substantial time investments in PA later.

This study's findings suggest that intervention boys are better at retaining certain key knowledge related to healthy eating. In particular, intervention boys tended to have a more accurate understanding of the role of carbohydrates, protein, and metabolism than girls. One can speculate that boys generally have more interest and therefore better recall of nutritional topics related to strength and energy than girls. Yet nutrition and PA-related curriculum could be made more engaging for girls. Indeed, OTU may have been developed with an inadvertent bias toward boys, stressing things such as protein for strength and carbohydrates for energy. OTU was created by a former male boxer, though with substantial educator input (Tony Lamka, personal communications, 2010-2012). Showing girls the connection more clearly and in a more engaging manner between different approaches to eating and exercise, on the one hand, and physical appearance and weight, on the other, may help motivate girls to make healthier choices. In regard to nutrition, this might for example involve showing girls more explicitly, and in a manner so that they internalize in their behavior, the link between high consumption of high-fat, high-sugar, and highly processed carbohydrate foods

and excess weight gain. This would help to respond to the control school teacher's plea, quoted earlier, to give girls—who want to be skinny—a health way to do so.

The above conclusions support and are supported by the importance of linking classroom learning to relevant applications to the student's life and interests (Kidwell, 2010). For example, as noted earlier, middle school girls are interested in being slim and beautiful; by showing girls how good nutrition and exercise can help them achieve these goals, girls may absorb learning about nutrition and exercise more effectively, and therefore potentially improve nutrition and exercise habits more. Relatedly, a more "girl-friendly" approach would also leverage the proven and broadly accepted *learner-centered* curriculum design theory perspective (Ornstein & Hunkins, 2009), as OTU already appears to do effectively for boys' nutrition knowledge. On a promising note, study results on physical activity indicate that OTU already positively impacts girls' PA attitude and behavior.

Some initiatives such as free in-classroom breakfasts, improved school lunch menus and portions, prohibition of sweet, high-sodium, and fatty food snacks from school vending machines, and various healthy messaging which students are receiving at school, indicate some support by school leaders, and are having some impact. The study survey responses implied that there is an increasing awareness, among control as well as intervention students, about the health implications of sodium, soda, and possibly other potentially harmful food and beverages, as well as the positives of eating more fruit and drinking water, and the importance of physical activity. Middle school nutrition knowledge curriculum may be contributing to this learning.

Nevertheless, in spite of superficial progress, the statistical reality across lower income communities is one of poor adolescent health and continuing CO. This study's other

survey responses show that control students' claims of caring about nutrition and PA appear particularly exaggerated and not materially implemented by many students. Growing awareness of health issues, and acknowledgement of the importance of good nutrition and physical activity, should not be confused with dramatically changing behavior enough to reverse health trends. Indeed, for example, there are widespread reports nationally that many students are not consuming substantial amounts of fruit and vegetables at school lunches, in spite of their increasing availability (Yee, 2012) and awareness of their value, though some studies have provided more hope (Taber, Chriqui, & Chaloupka, 2013; USDA, 2013). In this study, students in the control group perceived themselves as more physically active than intervention students did, but did not appear in reality to be running as much at recess as intervention students. Likewise, many school districts and children may be increasing their "lip service" to better nutrition and more physical activity, but is improved behavior really happening in any broad and deep sense, given the widespread lack of rigorous behavior-oriented nutrition and exercise education continued spirally over time?

It seems likely that many of the positive outcomes of the Operation Tone-Up intervention arise in substantial part from the high levels of rigor demanded by the program curriculum. When one considers how nonrigorous many traditional PE class sessions are, contrasted with the success of the more demanding PA interventions discussed here (Bronikowski et al., 2009; Jamner, Spruijt-Metz, Bassin, & Cooper, 2004; Sharma, 2006), it seems clear that both PE itself and PA interventions in schools must be made much more rigorous, in order to have a substantial impact on health. The Operation Tone-Up intervention's substantial and in many cases statistically significant effect sizes, in terms of healthier PA attitudes and PA behaviors, seem connected to the substantial improvements in

blood pressure and resting heart rate found in previous studies of Operation Tone-Up. These effect sizes appear materially higher than many other PA interventions documented in the literature, and certainly higher than in typical PE classes (Demetriou & Höner, 2012; Fjeldsoe et al., 2011; Kriemler et al., 2011; van Cauwenberghe, Maes, & Spittaels, 2011; van Stralen et al., 2011). Policy makers and implementers must avoid superficial solutions that give the impression that serious efforts are being made to improve children's health, yet do not demand enough of schools and students and do not last long enough to achieve material long-term impact and contribute to a serious reduction in obesity and related chronic health conditions. In addition, unless rigorous PA is frequent, long-lasting, mandatory, and effectively implemented, the literature indicates that we should expect little impact from PA interventions or PE.

Also, as noted in the literature, for maximum impact, parents should be included in the nutrition and PA education process. Relatedly, appropriate considerations should be made for ethnicity, as discussed earlier. In contrast to school-based programs, where generic programs not tailored by ethnicity have been successful, future programs which incorporate parents more fully should possibly be tailored to reflect Hispanic and other ethnicities' characteristics, including family dynamics, and possible preferences by some for, for example, Mexican cuisine, or dancing or soccer more than aerobic calisthentics. One possibility would be to provide a range of potential, effective approaches as a "menu" for families to improve nutrition and physical activity. Operation Tone-Up and many other interventions could increase their overall effectiveness, by better addressing the student's family context.

In brief, while there is not yet a widespread consensus on one or more particular, optimal nutrition and PA interventions and curricula, there is enough evidence to work with to implement effective programs. Best practices can now be identified, which have a significant impact on students' health behaviors, including helping to prevent childhood obesity. There are indications that at least several long-standing interventions have key, impactful elements to offer, in some cases with a positive impact on standardized test results as well. The HOPE2 study focuses on OrganWise Guys® and its Wisercise® PA component as its preferred interventions (D. Hollar, personal communications, March 9-14, 2012). OrganWise Guys appears to have a strong nutrition education program for elementary school students, with a range of grade-specific materials (The OrganWise Guys, 2011), which also conform to many states' curriculum standards (D. Hollar, personal communications, March 9-14, 2012). On the other hand, Operation Tone-Up appears to have a strong aerobic exercise component, which may be superior to the Wisercise approach. Also, CATCH or other interventions may be able to more effectively address the family and community components of school-based CO prevention (Coleman et al., 2005), than either Organwise Guys or OTU. We may be able to take the best practices from existing interventions, and bring them together into a comprehensive, highly effective, yet low cost program for schools. While there are promising approaches at the elementary school level, much more work needs to be done among middle school students. In order to maximize impact, as supported by curriculum theory, Grades 3-8, and indeed preK-12, should be thought of as an integrated continuum for health education.

However, one implementation caveat is that schools may be more comfortable and effective in teaching knowledge rather than attitudes and behaviors. Yet study results show

that nutrition knowledge alone is not enough to change nutrition practices, so knowledge learning must be supplemented in order to improve attitudes and behaviors. As observed in this study and elsewhere (Governali, Hodges, & Videto, 2005), there is a fundamental gap between health knowledge and healthy habits. This healthy behavior education challenge appears somewhat similar to moving from a more traditional, knowledge-oriented subject mastery approach, to the current more critical thinking-oriented pedagogical model (Ornstein & Hunkins, 2009; Schiro, 2008). Schools have much to learn in this area of habit formation, but health educators and effective intervention developers can help schools to improve.

Solutions should make it as easy as possible for existing school personnel to play an effective role. As one example noted earlier, Operation Tone-Up accomplishes this with DVDs and online videos, which permit even unfit teachers to ensure that exercises are led with sufficient vigor and form. This in turn allows teachers to focus on activity supervision rather than demonstration.

2. School-based health programs need to be accepted by educators and not just health professionals. In order to achieve this, these programs must utilize curriculum theory and demonstrate contributions to academic success, and they must ultimately be backed by inclusion in core curriculum standards and mandatory testing.

The best solution to a social issue is typically not a perfect solution, but arguably a highly effective, reasonable cost solution, which can realistically be accepted and implemented. This study's literature review noted many interventions' failure to consider implementation costs, which can severely restrict adoption. This study also identified health educators' continuing failure to use curriculum theory and to consider education leaders'

concerns, as key obstacles which must be addressed. In order to truly change individuals' behavior longer term, in a manner acceptable to educators, an integrated, long-term, behavior change-oriented curricular approach based on curriculum design theory should be used by health practitioners. In addition, in-school curriculum-based health programs should demonstrate that they have a positive impact on academics, as well as health. Ultimately, though, the maximum impact will only be achieved when health standards are included in core curriculum standards and tests.

Following health learning psychology precepts comes naturally to CO prevention health educators. In fact, it comes so naturally that many do not even discuss their guiding principles and theoretical assumptions when developing or evaluating programs, as seen in the literature review. Those behavioral, cognitive, social-ecological, and sociocultural perspectives are valuable, and have helped to develop and implement a number of promising CO prevention programs. But it is now necessary for in-school CO prevention program practitioners to move beyond short-term interventions and evaluations to longer term orientations, and relatedly, from health education psychology to curriculum theory. By utilizing and communicating with curriculum theory principles, CO prevention programs can speak the language of school district curriculum and instruction gatekeepers, and more easily persuade them of their CO programs' pedagogical strengths, as well as demonstrating how nutrition and fitness programs can fit into the existing core academic curriculum.

In-school CO prevention practitioners can also help to maximize the impact of their program, by revising their programs using established curricular concepts that are proven to work in teaching all subjects in schools. Curriculum theory improves the quality of their programs, and can expand their access to schools. By adding longer term program analysis

and evidence as well, health educators may finally have the ingredients they need to strengthen their access and impact, and to help sustainably improve children's nutrition and fitness.

Health educators need to persuade school leaders, in school leaders' own curricular and performance metrics language, and recognizing school leaders' goals, concerns, and constraints, how nutrition and exercise education can help school leaders achieve their goals. Curriculum theory can help health professionals communicate persuasively with educational leaders and curriculum decision-makers. Curriculum theory can also help health program developers to shift from a short-term intervention approach to include critical long-term curriculum-integrated elements. By the same token, if rigorous, behavior-oriented nutrition and fitness education in schools were designed and operated as an ongoing part of the overall school curriculum's design and implementation, instead of being implemented as one-time or intermittent programs, longer term results should be easier to achieve, more definitive, and more readily acknowledged, including their positive impact on academic performance.

Curriculum theory, in addition to the better known elements of scope and sequence, brings in other design elements important for long-term health education and behavior change. These include broadening the definition of intervention scope to include multi-year duration, with reinforcing spiral continuity, as well as integration, articulation, and balance. Taken together, these elements emphasize the importance of interdependence and synergies in the spiral development of curriculum, knowledge, and critical thinking. Indeed, this attention to curriculum theory elements, whether consciously or not, appears to have been a key part of OrganWise Guys' and Operation Tone-Up's effectiveness and acceptance into schools.

Study students generally, whether former intervention participants or not, perceived a major impact on their academic performance from both the healthiness of their eating and PA. Based on the results of this study, it appears that students recognize this themselves from their own life experience. Both control and intervention students report self-awareness of the impact of nutrition and physical activity on their academic performance, and they perceive that good nutrition and being active help them to do better in class.

Nutrition and exercise learning could help educators and students achieve their academic goals, while helping students develop healthier habits, in a synergistic coordinated manner, at low cost. By doing so, students would be much better prepared for success in life. Nevertheless, school leaders continue to see school time as a limited "pie," where maximizing time spent directly on reading, writing, math, and so on, is perceived as more effective than also investing some time in nutrition and physical education and activity. Are schools extending their self-proclaimed, "learner-centered" educational philosophy to listen carefully to students' perceptions of what students need to succeed, beyond classroom academic instruction focused almost exclusively on core curriculum academic subjects? Are they seriously reviewing the growing evidence for a positive impact from classroom time spent on nutrition and vigorous PA? Or are schools persisting in a narrower, adult-driven, and arguably student-unfriendly focus on core academics alone?

A growing body of evidence shows that an investment of precious school time in effective nutrition and PA learning and activity pays off, as exercise and in some studies better nutrition appear to help students to succeed in the classroom (Ahamed et al., 2007; CDC, 2010; Chomitz et al., 2009; Hollar, Messiah, et al., 2010). School leaders should recognize this research, and adjust their curriculum and school time allocation accordingly.

At the same time, policy makers and implementers including school leaders must avoid superficial "solutions" that give the false impression that serious efforts are being made to improve children's health. Real solutions must demand enough of schools and students and last long enough to achieve material long-term impact. Only a serious, well-planned and well-implemented, sustained investment will contribute to a serious reduction in obesity and related chronic health conditions.

Hollar et al.'s HOPS study (2010) and other studies show that the time invested in effective nutrition and exercise education can be compensated for by significantly improved math performance. While reading scores did not improve in a statistically significant manner for the initial HOPS study intervention group as a whole, there were substantial increases in reading scores for Hispanic and African American students compared to control students (Hollar, Lombardo, et al., 2010; Hollar, Messiah, et al., 2010). It would not be surprising if some other subgroups improved their reading significantly, particularly among the worst fit with worse than average reading scores. The HOPE2 follow-up study to HOPS (D. Hollar, personal communications, March 9-14, 2012; Hollar, Messiah et al., 2010) may be the first to prove across a large variety of school districts and states, that a CO intervention can both prevent CO and improve math scores, and possibly reading scores as well; at any rate, not reduce reading scores in spite of the time reallocation to nutrition and PA. This should help further convince many school districts to try implementing a rigorous, effective nutrition and exercise program. Seemingly reinforcing these outcomes, a medium-size school district in California has experienced substantial improvements in standardized test scores, following introduction of Operation Tone-Up (J. Seymour, personal communications, April 18, 2013).

While there is sufficient evidence to support expanding health education within the current school calendar without harming academic outcomes, it may be easier to gain school leaders' support by increasing the school time "pie" in hours per day and/or days per year, rather than trying to persuade educators to shoe-horn substantially more nutrition and PA education into the existing, crowded school schedule. What is more, expanding time in school has been demonstrated to help vulnerable populations, in particular, to perform better academically (Patall, 2010). Extended school time therefore offers a win-win opportunity to build a coalition between school leaders, health educators, and their lower-income communities. But increasing time spent on effective health education in an expanded school schedule might still not be enough.

An old, widely accepted aphorism declares that, "What gets measured gets managed" (Leboeuf, 1985). In education, a similar bromide observes that, "What gets tested gets taught" (Google search results, 2013). To effect change, increased expectations of deliverables by the education system must be reflected in school performance metrics. PreK-12 education must again become more holistic, with much higher expectations for physical/health as well as intellectual/academic outcomes. In the current high-stakes standardized test-based education environment, this includes developing health-related core curriculum and testing standards, and holding schools accountable for nutrition and PA test results. Indeed, core curriculum standards as reflected in standardized tests in schools are broadly credited with defining how classroom teaching time is allocated (Jennings & Rentner, 2006; Manzo, 2005).

This situation requires developing health-related core curriculum and testing standards and standardized test components, and holding schools accountable for nutrition

and PA test results. Since common core standards and their counterpart test questions are currently focused on reading, writing, math, and selected social and natural sciences, these are the subjects which schools focus on, to the increasing exclusion of the arts (Heilig, Cole, & Aguilar, 2010), physical education (Amis, Wright, Dyson, Vardaman, & Ferry, 2012), and health (Mayer, Smith, & McDermott, 2011). By the same token, by reaching agreement on the value of including health education in the common core curriculum and associated standardized tests, health education would receive more classroom time and attention by school administrators and teachers.

Nevertheless, increased school time with integrated, effective health education curriculum included into core standards and tests is only one facet of the policy changes needed to substantially reduce the chronic health conditions epidemic, and would require a substantial increase in public funds for education.

Broader Implications

The above study conclusions should be supplemented by broader policy and political implications as well. Ultimately, we cannot hope to make a significant dent in complex chronic health conditions costing hundreds of billions of dollars annually, without broadening our vision beyond childhood obesity and health education in the elementary and middle school systems. As part of a comprehensive, realistic solution that leads to fundamental lifelong behavior change, we must also make some other broad and profound social impact investments.

3. Our society must prioritize prevention and leverage our political, health care, education, tax, and insurance systems with more effective coalition-building and persuasion strategies to promote impactful policies and practices. The combined impact can help us to curb the long-standing chronic health conditions epidemic.

Education should be viewed within a context of broader policy and practice improvements in order to help address chronic health conditions' causes. These conditions result to a major extent from unhealthy nutrition (including tobacco and alcohol consumption), unhealthy levels of physical activity, and many related habits begun early in life, well before adulthood. In many cases, diabetes, heart disease, hypertension, high cholesterol, and other chronic conditions can be substantially reduced and prevented by intervening effectively early in life (CDC, 2009), before habits are formed and when adapting new habits is easier. But these chronic health conditions are perpetuated and worsened by many other factors outside the education system, as discussed in this study's literature review. Indeed, many of these influencers occur chronologically before and after the preK-12 education system. As a result, school-based reforms should be supplemented by other policies and practices before and after preK-12 education. The main causes must be addressed by multiple systems. Furthermore, the key decision-makers in these systems must be persuaded of the value of reform.

Curriculum theory and healthy psychology principles of reinforcement and maintenance imply the need for this multi-system, longer term, lifespan learning perspective. This truly comprehensive, holistic, lifespan-oriented approach builds on and expands the by now well-accepted concept of lifelong learning. It creates the potential for ongoing reinforcement of healthy behavior learning, so that good habits are maintained lifelong.

Indeed, lifelong health learning is arguably as important as lifelong career learning; after all, good health allows one to go to work in the first place, to work more often and more productively, to stay alive, support a family, and earn a better living.

For example, preK-12 health education could be combined with systematic, healthy behavior-oriented maternity and early childhood health learning interventions before preschool begins. In addition, later preK-12 education could be supplemented by lifelong tax- and health-insurance-based healthy behavior incentives for working teens and adults, in order to help turn the tide on the chronic health conditions epidemic. Nevertheless, the more ambitious the effort and the associated investment of time and resources needed, the more persuasive the arguments and the broader the political coalitions must be.

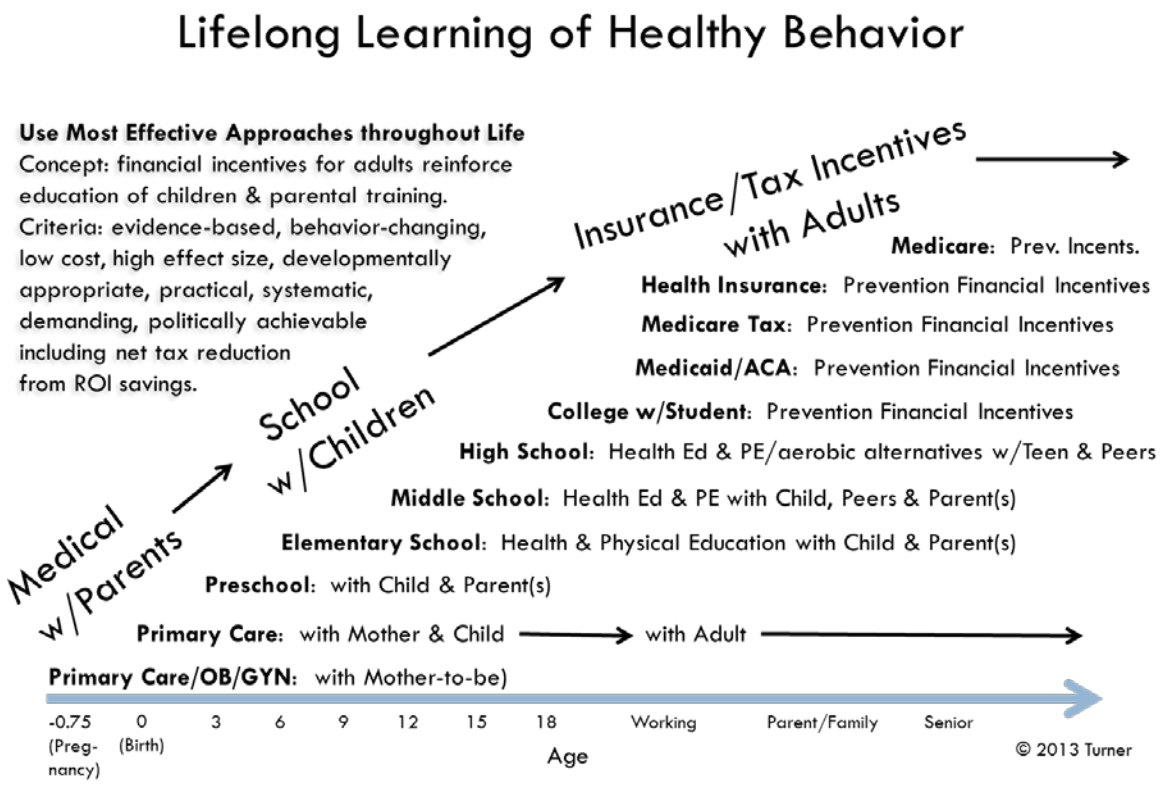

Figure 18. Transformative lifelong learning in 3 stages.

The continuing increases in health care and related entitlement costs make proactive healthy behavior initiatives timely. Substantial public and private savings could result from Medicaid, Affordable Care Act (ACA; "Obamacare"), Medicare, and private health insurance-reimbursed health care cost reductions. These savings due to healthier behaviors by Americans could provide long-term funding for preventive health programs, in schools and elsewhere, while improving the quality of life and disposable income for tens of millions of Americans (Butler & Haislmaier, 1989; White House Council of Economic Advisers, 2009). In addition, chronic condition-related health care cost reductions could help secure the long-term financial viability of several of the U.S.'s largest entitlement programs intended to provide health care to lower income and older Americans. The savings in taxpayer-funded costs could also provide money for broad-based tax cuts and government debt reduction benefitting virtually all Americans. These potential benefits can attract a broad coalition across the political spectrum.

Much CO prevention-related academic research appears quite abstract, impersonal or even passion-less. Yet the topic is an extremely serious, heart-wrenching, highly emotional one, with severe consequences on individuals, families, and society. One question is, are we overlooking some potential, compelling evidence and effective communications strategies to support changes in policy related to obesity/overweight and related chronic health conditions? The traditional academic research process purports to be one of objective, logical, dispassionate analysis. Yet in the obesity arena, change advocates are up against very well-funded corporate interests, who manipulate the public psychologically through advertising and politically through lobbying and media campaigns. Health change advocates also face ideological opponents, who advocate ideas over facts, or insist on huge

expenditures which cannot be sustained. And these forces have in many respects been winning.

Are CO, public health, and health education scholar-practitioners and advocates using enough anecdotal, personally compelling stories, enough persuasive qualitative data, as well as presenting valid quantitative data as effectively as they should, and otherwise communicating persuasively enough? Are we doing enough to authentically and legitimately supplement, and add convincing emotional power, to traditional academic evidence, yet with statistical validity, honesty and academic integrity? At the same time, are we marshaling data persuasively on the economic costs, including the costs to health insurance premium payers and to taxpayers, of obesity and poor health resulting from unhealthy behaviors? Are we effectively contrasting the cost-benefits of prevention vs. cure, of rigorous health behavior education vs. disease management, and comparing effective proactive preventive approaches starting early in life to the reactive cure-oriented treatments for adults, which dominate Medicaid, Medicare, and private health insurance? Are we effectively pointing out the potential to re-allocate money spent on disease management to other, more positive and productive areas of the economy, with resulting increases in employment and disposable income? By arguing persuasively based on both the social and the economic costs of obesity and poor health, across both the private and public sectors, and at all levels of government and society, total aggregated short- and long-term costs can be contrasted with the benefits of rigorous school-based and other preventive approaches. This comprehensive socioeconomic "ROI" (return on investment) measurement should make it substantially easier to develop the political coalitions needed to invest in and sustain behavior change.

Limitations

As with any study in such a broad complex area, there are a number of limitations to this study. These include generic research issues with self-reported data and related biases, including differences between reported and actual behavior, student self-categorization of ethnicity including Hispanic/non-Hispanic, and student responses that they received a free lunch—which was assumed to indicate low SES. These also include limitations to the post-hoc, retrospective method, such as not totally randomized or fully controlled participants. In addition, much of the survey was focused on knowledge and attitudes, with limited behavior-based variables, and no independently observed behavior. There was limited intervention significance and effect sizes in certain cases. Although boxplots provide some support, they are not regression-based and do not control as well as regressions for confounding influences. Operation Tone-Up teachers to-date may have been better than an average teacher would be in teaching this nutrition and exercise intervention on a larger scale. In addition, teachers to-date may have received more attention from OTU's operator, the non-profit Accept The Challenge, than would be feasible for larger scale implementation. Also, physiological metrics such as blood pressure or heart rate monitoring were not used to help validate the more subjective metrics of students' survey responses in this study, though prior studies provided substantial physiological evidence.

Related to the above limitations of this study, there are two other conclusions from this study which point to possible limitations of in-school health intervention research, in general.

First, this study's surveying process highlighted some material shortcomings of standard research lines of inquiry in health psychology and health education. While there are

clear advantages in being able to compare "apples-to-apples" between studies across locations, populations, and time periods, by using the same terminology in surveys each time, there are also some changing nutrition and activity habits among children, which researchers must begin to address. In particular, there appear to be problems with asking in student surveys about "soda" as a representative of typical unhealthy sweet beverages, in an era when energy drinks and non-carbonated sweet drinks are becoming more common and enticing alternatives to carbonated soda among children, and when many "sweet drinks" may be artificially sweetened with non-caloric alternatives. Going forward, how can survey questions and other research inquiries be phrased to be more relevant and better understood by today's students? By the same token, using "watching TV" as a typical bad PA habit is becoming less relevant to real-world children. We are now in an era when playing video games or using social media may be more typical and more enticing alternatives than watching television among elementary and middle school students, as distracting alternatives to rigorous physical activity. Researchers should consider rephrasing survey questions and other research inquiries along these lines.

Another, broader limitation of CO research is the focus on BMI. Is there so much emphasis on BMI, that more direct health metrics such as heart rate, blood pressure, aerobic fitness, and muscular strength are being de-emphasized? Key research indicates that fitness can be as important for health as BMI among adults (Frantz, 2002; Martin, 2011). Fitness also helps to mitigate the harmful effects of high BMI and metabolic syndrome among children, and to lower the risk of developing metabolic syndrome (DuBose et al., 2007; McMurray, 2010). By the same token, approximately 40% of normal weight adult Americans have metabolic dysfunctions typically associated with obesity (Weiss et al.,

2013), and are at risk of developing serious yet preventable health conditions, in large part due to lack of fitness (Lustig, 2013). Interventions that boost fitness can have a substantial health benefit, even if BMI does not decrease substantially; indeed, weight loss-oriented strategies may in many cases not be age-appropriate or feasible (Berman, Weigensberg, & Spruijt-Metz, 2012). Furthermore, the focus on BMI may also indirectly support societal prejudice based on body proportions (Brewis, 2010). Indeed, some anti-obesity public health campaigns seem to stigmatize obese individuals, even though there is no evidence that stigmatization helps reduce obesity, and this strategy may even be counterproductive (Vartanian & Smyth, 2013). Also, stigmatizing obese individuals may, because of obesity's association with lower income individuals, help engender inter-class conflicts, as well as personal trauma. Given the "moving target" of rapidly growing bodies at adolescence, and the ultimate goal of good health rather than particular body proportions, is the right balance being placed on various health measures by CO prevention scholar-practitioners, including those funding CO-related interventions and evaluations?

Nevertheless, in spite of the above limitations, this study's results, and conclusions which we can draw from them, provide valuable insights into the potential for improving health education and its long-term impact on individuals' health.

Potential Research Areas

This study has focused on particular areas, and uncovered the potential for many other lines of inquiry. These include large-scale pre-post, prospective, longitudinal RCT of Operation Tone-Up (control vs. OTU; baseline, in-progress, and endline); a study comparing OTU impact to more widespread interventions such as OrganWiseGuys/Wisercise! and CATCH (and controls); and research on how to combine the best practices of the most

impactful interventions. For example, the latter could include a study utilizing the most effective elements of existing interventions, ideally combined with the most effective elements of standard school curricular health education, and researching this "best practices" program. Other research could include a study showing academic performance impact of OTU; and research on how to integrate key, effective CO intervention and health education principles into the core curriculum in ways that also boost student engagement and overall academic performance. Another line of inquiry could include research on how to keep girls engaged in nutrition and physical education by (a) learning the impact of nutrition and exercise on physical appearance and (b) participating in rigorous PA but with friends. A qualitative study could also be conducted on how to bridge health education and curriculum and instruction communities of practice.

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APPENDICES

[Note: Documents are in most cases formatted somewhat differently here from the original versions distributed to students, parents, school personnel, et al.]

Appendix A - Demographics, Frequencies, Descriptive Statistics

Grade

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	1	.3	.3	.3
	6	85	23.0	23.2	23.4
	7	150	40.5	40.9	64.3
	8	131	35.4	35.7	100.0
	Total	367	99.2	100.0	
Missing	99	3	.8		
Total		370	100.0		

Age (yrs)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	7	1	.3	.3	.3
	10	1	.3	.3	.5
	11	25	6.8	6.8	7.4
	12	93	25.1	25.3	32.7
	13	134	36.2	36.5	69.2
	14	105	28.4	28.6	97.8
	15	8	2.2	2.2	100.0
	Total	367	99.2	100.0	
Missing	99	3	.8		
Total		370	100.0		

Sex

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Girl	198	53.5	54.8	54.8
	Boy	163	44.1	45.2	100.0
	Total	361	97.6	100.0	
Missing	99	8	2.2		
	System	1	.3		
	Total	9	2.4		
Total		370	100.0		

Did you receive free lunch?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	103	27.8	34.0	34.0
	Yes	200	54.1	66.0	100.0
	Total	303	81.9	100.0	
Missing	Don't Know	53	14.3		
	99	14	3.8		
	Total	67	18.1		
Total		370	100.0		

Ethnicity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	White (including Hispanic/Mex-Amer)	145	39.2	65.3	65.3
	African-American	29	7.8	13.1	78.4
	Native-American	27	7.3	12.2	90.5
	Asian-American	12	3.2	5.4	95.9
	Other	9	2.4	4.1	100.0
	Total	222	60.0	100.0	
Missing	99	147	39.7		
	System	1	.3		
	Total	148	40.0		
Total		370	100.0		

Hispanic

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	non-Hispanic	170	45.9	49.1	49.1
	Hispanic	176	47.6	50.9	100.0
	Total	346	93.5	100.0	
Missing	99	24	6.5		
Total		370	100.0		

Did you participate in Operation Tone-Up?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	187	50.5	61.1	61.1
	Yes	119	32.2	38.9	100.0
	Total	306	82.7	100.0	
Missing	Don't Know	61	16.5		
	99	3	.8		
	Total	64	17.3		
Total		370	100.0		

Number of years student says s/he participated in OTU

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.0	243	65.7	65.7	65.7
	1.0	66	17.8	17.8	83.5
	2.0	29	7.8	7.8	91.4
	3.0	26	7.0	7.0	98.4
	4.0	6	1.6	1.6	100.0
	Total	370	100.0	100.0	

Does Scott think student participated in OTU, given which school they attended in which years etc

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	238	64.3	64.3	64.3
	1	132	35.7	35.7	100.0
	Total	370	100.0	100.0	

Number of years Scott thinks student participated in OTU when all data considered

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.0	238	64.3	64.3	64.3
	.5	6	1.6	1.6	65.9
	1.0	35	9.5	9.5	75.4
	1.5	5	1.4	1.4	76.8
	2.0	59	15.9	15.9	92.7
	2.5	14	3.8	3.8	96.5
	3.0	12	3.2	3.2	99.7
	4.0	1	.3	.3	100.0
	Total	370	100.0	100.0	

Number of years Scott thinks it has been since student participated in OTU

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.0	24	6.5	18.2	18.2
	1.5	14	3.8	10.6	28.8
	2.5	66	17.8	50.0	78.8
	3.5	24	6.5	18.2	97.0
	4.5	4	1.1	3.0	100.0
	Total	132	35.7	100.0	
Missing	System	238	64.3		
Total		370	100.0		

Grade

Did you participate in Operation Tone-Up?			Frequency	Percent	Valid Percent	Cumulative Percent
No	Valid	5	1	.5	.5	.5
		6	18	9.6	9.8	10.3
		7	84	44.9	45.7	56.0
		8	81	43.3	44.0	100.0
		Total	184	98.4	100.0	
	Missing	99	3	1.6		
	Total		187	100.0		
Yes	Valid	6	60	50.4	50.4	50.4
		7	28	23.5	23.5	73.9
		8	31	26.1	26.1	100.0
		Total	119	100.0	100.0	
Don't Know	Valid	6	6	9.8	9.8	9.8
		7	36	59.0	59.0	68.9
		8	19	31.1	31.1	100.0
		Total	61	100.0	100.0	
99	Valid	6	1	33.3	33.3	33.3
		7	2	66.7	66.7	100.0
		Total	3	100.0	100.0	

Age (yrs)

Did you participate in Operation Tone-Up?			Frequency	Percent	Valid Percent	Cumulative Percent
No	Valid	7	1	.5	.5	.5
		10	1	.5	.5	1.1
		11	3	1.6	1.6	2.7
		12	28	15.0	15.1	17.7
		13	76	40.6	40.9	58.6
		14	71	38.0	38.2	96.8
		15	6	3.2	3.2	100.0
		Total	186	99.5	100.0	
	Missing	99	1	.5		
	Total		187	100.0		
Yes	Valid	11	18	15.1	15.3	15.3
		12	49	41.2	41.5	56.8
		13	27	22.7	22.9	79.7
		14	23	19.3	19.5	99.2
		15	1	.8	.8	100.0
		Total	118	99.2	100.0	
	Missing	99	1	.8		
	Total		119	100.0		
Don't Know	Valid	11	3	4.9	5.0	5.0
		12	16	26.2	26.7	31.7
		13	29	47.5	48.3	80.0
		14	11	18.0	18.3	98.3
		15	1	1.6	1.7	100.0
		Total	60	98.4	100.0	
	Missing	99	1	1.6		
	Total		61	100.0		
99	Valid	11	1	33.3	33.3	33.3
		13	2	66.7	66.7	100.0
		Total	3	100.0	100.0	

Sex

Did you participate in Operation Tone-Up?			Frequency	Percent	Valid Percent	Cumulative Percent
No	Valid	Girl	92	49.2	50.3	50.3
		Boy	91	48.7	49.7	100.0
		Total	183	97.9	100.0	
	Missing	99	3	1.6		
		System	1	.5		
		Total	4	2.1		
	Total		187	100.0		
Yes	Valid	Girl	69	58.0	60.0	60.0
		Boy	46	38.7	40.0	100.0
		Total	115	96.6	100.0	
	Missing	99	4	3.4		
	Total		119	100.0		
Don't Know	Valid	Girl	35	57.4	58.3	58.3
		Boy	25	41.0	41.7	100.0
		Total	60	98.4	100.0	
	Missing	99	1	1.6		
	Total		61	100.0		
99	Valid	Girl	2	66.7	66.7	66.7
		Boy	1	33.3	33.3	100.0
		Total	3	100.0	100.0	

Did you receive free lunch?

Did you participate in Operation Tone-Up?			Frequency	Percent	Valid Percent	Cumulative Percent
		No	60	32.1	39.7	39.7
	Valid	Yes	91	48.7	60.3	100.0
		Total	151	80.7	100.0	
No		Don't Know	32	17.1		
	Missing	99	4	2.1		
		Total	36	19.3		
	Total		187	100.0		
		No	28	23.5	27.2	27.2
	Valid	Yes	75	63.0	72.8	100.0
		Total	103	86.6	100.0	
Yes		Don't Know	11	9.2		
	Missing	99	5	4.2		
		Total	16	13.4		
	Total		119	100.0		
		No	15	24.6	31.3	31.3
	Valid	Yes	33	54.1	68.8	100.0
		Total	48	78.7	100.0	
Don't Know		Don't Know	8	13.1		
	Missing	99	5	8.2		
		Total	13	21.3		
	Total		61	100.0		
	Valid	Yes	1	33.3	100.0	100.0
99	Missing	Don't Know	2	66.7		
	Total		3	100.0		

Ethnicity

Did you participate in Operation Tone-Up?			Frequency	Percent	Valid Percent	Cumulative Percent
No	Valid	White (including Hispanic/Mex-Amer)	89	47.6	69.0	69.0
		African-American	16	8.6	12.4	81.4
		Native-American	10	5.3	7.8	89.1
		Asian-American	10	5.3	7.8	96.9
		Other	4	2.1	3.1	100.0
		Total	129	69.0	100.0	
	Missing	99	58	31.0		
	Total		187	100.0		
Yes	Valid	White (including Hispanic/Mex-Amer)	37	31.1	62.7	62.7
		African-American	8	6.7	13.6	76.3
		Native-American	10	8.4	16.9	93.2
		Other	4	3.4	6.8	100.0
		Total	59	49.6	100.0	
	Missing	99	59	49.6		
		System	1	.8		
		Total	60	50.4		
	Total		119	100.0		
Don't Know	Valid	White (including Hispanic/Mex-Amer)	18	29.5	54.5	54.5
		African-American	5	8.2	15.2	69.7
		Native-American	7	11.5	21.2	90.9
		Asian-American	2	3.3	6.1	97.0
		Other	1	1.6	3.0	100.0
		Total	33	54.1	100.0	
	Missing	99	28	45.9		
	Total		61	100.0		
99	Valid	White (including Hispanic/Mex-Amer)	1	33.3	100.0	100.0
	Missing	99	2	66.7		
	Total		3	100.0		

Hispanic

Did you participate in Operation Tone-Up?			Frequency	Percent	Valid Percent	Cumulative Percent
No	Valid	non-Hispanic	100	53.5	58.8	58.8
		Hispanic	70	37.4	41.2	100.0
		Total	170	90.9	100.0	
	Missing	99	17	9.1		
	Total		187	100.0		
Yes	Valid	non-Hispanic	49	41.2	42.2	42.2
		Hispanic	67	56.3	57.8	100.0
		Total	116	97.5	100.0	
	Missing	99	3	2.5		
	Total		119	100.0		
Don't Know	Valid	non-Hispanic	20	32.8	35.1	35.1
		Hispanic	37	60.7	64.9	100.0
		Total	57	93.4	100.0	
	Missing	99	4	6.6		
	Total		61	100.0		
99	Valid	non-Hispanic	1	33.3	33.3	33.3
		Hispanic	2	66.7	66.7	100.0
		Total	3	100.0	100.0	

Appendix B - Student Survey Questionnaire

[survey was distributed formatted with .3"-.4" margins to fit on two sides of one sheet]

***Student Survey Questionnaire Instructions**: – Thank you very much for answering the below questions as accurately as possible. – Please try to answer each question completely. – Your answers will not be provided to anyone except the researchers, so your privacy is protected. – If you do not wish to answer a particular survey question, you do not have to answer it. –Also, you can choose not to answer any questions, and just hand this survey back blank. – Also, you can choose not to have your blood pressure or heart rate measured. – If your parent or guardian did not give permission for you to participate, your answers will not be used, and you do not have to complete this form, and you can hand the survey form back blank. – Your honest answers can help us to improve the health of students in our schools. – We much appreciate your help. (survey version 04/10/2012 – draft)*

School _____ **Grade** _____ **Teacher Name**

_____ **Day of Week** _____ **Date**_____ **Time** _____

Did you have lunch yet today? (*circle*) Yes No **Do you receive free lunches at school?** Yes No I don't know

My First & Last Name is_____ **My age is** _____ years old **I am** *(circle)*: Boy Girl

If you know the **Zip Code** of where you live, please write it here: _____

I am *(circle **only one**)*: White African-American/Black Native-American/American Indian Asian-American

Other (describe)_____

I consider myself Hispanic (for example, Mexican-American, or I speak Spanish at home) *(circle **only one**)*: Yes No

Please list all schools in the USA where you attended: **Grade 3:**_____ **Grade 4:** _____ **Grade 5:** _____ **Grade 6:** _____

Grade 7: _____

Did you participate in Operation Tone-Up in the past? *(circle **only one**)* Yes No I don't know

- **If you participated,** please circle the grades when you participated (***circle one or more***): 2 3 4 5 6
- **If you participated, who were your teachers?** *(please list all teachers' names that you remember)*

_____ _____ _____

_____

Please answer the following questions as best you can by circling the right answer or filling in the blank:

1) Did Operation Tone-Up use cartoon characters? *(please circle **only one answer**)* Yes No I don't know

2) What does protein do for your body that other nutrients can't?
*(circle **only one**)* Gives energy Builds muscle Provides vitamins I don't know

3) What do carbohydrates do for your body that other nutrients can't?
*(circle **only one**)* Gives energy Builds muscle Provides vitamins I don't know

4) Metabolism is the process by which the body breaks down food to supply energy. *(circle **one**)* True False I don't know

5) Is eating lots of food with lots of sodium bad for you? *(circle **only one**)* Yes No I don't know

6) When was the last time you ate a piece of fruit? *(circle **only one**)* Today Yesterday 2 or 3 days ago 1 or 2 weeks or ago

7) During a typical day, about how many times do you usually eat fruit or vegetables? *(circle **one**)* 0 1 2 3 4 or more

8) During a typical day, how many times do you usually drink soda? *(circle **only one**)* 0 1 2 3 4 or more

9) Which would you rather drink? (*circle **only one***) A soda Water

10) Which would you rather have for a snack? (*circle **only one***) A candy bar A piece of fruit

TURN OVER PAGE PLEASE – There are more questions on the back!

11) About how many times did you eat last week at a fast food restaurant? *(circle **one**)* 0 1 2 3 4 or more

12) How important is eating healthy foods? *(circle **only one**)*

Not important A little important Somewhat important Important Very important

13) Please describe briefly why eating and drinking healthy things is important:

_____

_____

_____

14) Compared to other kids in your grade, how healthy do you think the food that you eat is? *(circle **only one**)*

Less healthy About the same More healthy I don't know

15) **How well do you do in class** when you eat healthy food, compared to when you do not eat healthy food? *(circle **only one**)*

I do worse with healthy food I do about the same with healthy food I do better with healthy food I don't know

For the questions below, let's define physical activity and being physically active as *moving your body enough that it makes you breathe harder or get out of breath some of the time*. Examples include running, biking, playing tag, soccer, basketball, & football:

16) What type of physical activity did you do, last time you were active, not counting PE?

_____

17) At recess, how much do you usually run around? *(circle **only one**)* None A little Sometimes Most of the time All the time

18) During recess, would you rather? *(circle **only one**)* Talk with friends Play a game that includes running with friends

19) Compared to other kids in your grade, how physically active are you?

*(circle only **one**)* I am less active I am active about the same as other kids I am more active I don't know

20) After school, would you rather? *(circle **only one***) Watch TV Play a game outdoors that includes running with friends

21) How important is physical activity? *(circle **only one**)*
Not important A little important Somewhat important Important Very important

22) Please describe briefly why physical activity is important:

_____

_____

_____

23) How do you do in class and with your school work when you have been active, compared to when you are not active? *(circle **one**)*
I do worse when I have been active I do about the same I do better when I have been active I don't know

24) Coke, Pepsi, Mountain Dew, Red Bull, Monster and other energy drinks, coffee, and tea all contain caffeine. Did you drink anything with caffeine in it today? (*circle **only one***) Yes No I don't know

Please check to make sure you answered all of the questions that you wish to answer. Then raise your hand when you are finished.

Please FOLLOW THE RESEARCHER'S DIRECTIONS to measure your heart rate. Please hold still and breathe calmly.
Please WRITE DOWN YOUR LOWEST HEART RATE. Then raise your hand for the researcher. Thank you.

Resting heart rate pulse: **Beats per minute**_____

xxxxxx STOP HERE xxxxxxxxxxxx STOP HERE xxxxxxxxxxxx STOP HERE xxxxxxxxxxxx STOP HERE xxxxxxxxxxxx

Parental Consent received? Yes No Researcher initials _____ Research Notes:

_____

Appendix C – School Personnel Interview Protocol

Explanation to interviewees: We are doing a study on the impact of Operation Tone-Up (a childhood obesity prevention, nutrition and exercise program). We are interviewing school district personnel including teachers, nurses, and district staff, to determine what nutrition and exercise initiatives were undertaken in recent years, in order to increase students' knowledge of nutrition, increase students' physical activity, etc. This will help us determine what other factors may have contributed to students' nutrition and exercise knowledge and behavior besides Operation Tone-Up, and to factor those other elements into our research study.

Have employee review and sign consent form: Signed? *(circle one)* Yes No

Comments: _____

Staff Name _____ School/District/Dept. _____

Title _____ Function: Teacher Nurse Other: _____

Which School or Schools and Grades are Your Referring to?: _____

Was Operation Tone-Up offered in your school? Yes No Not sure

We would like to explore with you:

What are the primary nutrition and physical activity initiatives in your school or school district that have been undertaken over the last 5-10 years? At what grade levels and at which schools? What are the primary curricula and other methods?

Instructions to researcher:

- Researcher to complete the following pages.
- Use multiple copies of each page-form as needed to describe multiple Initiatives besides Operation Tone-Up.
- Put any other comments below.

Staff Name _____ School/District/Dept. _____

<u>What has been done in your school to improve nutrition knowledge and behavior?</u>

Initiative(s) descriptions:

When started? How long continued?:

Grade Level(s):

School(s):

Principal Curricula:

Other Instructional/Delivery Methods:

What impact do you feel these initiatives have had? Have outcomes been measured?

<u>For elementary school employees:</u>

In your opinion, to the best of your understanding, was OTU the principal <u>school-based</u> influence on students' nutrition knowledge and behavior?

Yes No Not sure

Comments:

How would you compare other <u>school-based</u> influences' impact to OTU?: (circle one)

Much Less than OTU Somewhat Less About Same Somewhat More Much More Don't Know

If you had to put a percentage on the relative influence of OTU compared to all other <u>school-based</u> influences that you know of, what % what you put OTU's influence level at?:

0% 20% 40% 60% 80% 100% Other _____ % Not sure

Other Comments?:

Staff Name _____ School/District/Dept. _____

<u>What else has been done in your school to improve food and drink at school lunches (and breakfasts if relevant) and at school vending machines etc.?</u>

Initiative(s) descriptions:

When started? How long continued?:

Grade Level(s):

School(s):

Information provided to students about this?:

What impact do you feel these initiatives have had? Have outcomes been measured?

[For elementary school personnel:]

How would you compare their impact to OTU?: (circle one)

Much Less than OTU Somewhat Less About Same Somewhat More Much More Don't Know

If you had to put a percentage on the relative influence of OTU compared to school lunch, breakfast and snack influences that you know of, what % what you put OTU's influence level at?:

0% 20% 40% 60% 80% 100% Other _____ % Not sure

Other Comments?:

Staff Name _____ School/District/Dept. _____

What else has been done in your school to increase physical activity?

Initiative(s) descriptions:

When started? How long continued?:

Grade Level(s):

School(s):

Principal Curricula:

Other Instructional/Delivery Methods:

PE? Recess? In-classroom? After-school?:

[For elementary school personnel:]

In your opinion, to the best of your understanding, was OTU the principal school-based influence on students' exercise knowledge and behavior?

Yes No Not sure

How would you compare other school-based influences' impact to OTU?: (circle one)

Much Less than OTU Somewhat Less About Same Somewhat More Much More Don't Know

If you had to put a percentage on the relative influence of OTU compared to all other school-based influences on exercise knowledge & behavior that you know of, what % would you put OTU's influence level at?:

0% 20% 40% 60% 80% 100% Other _____ % Not sure

Other Comments?:

Staff Name _____ School/District/Dept. _____

Including any non-school factors, as well as school, what would you say are the primary influences on your students' nutrition and exercise habits?

(Unprompted):

(Prompted below):

Which would you say have been a more important influence on the children in your classroom?

Family or School or Other factors? Please explain and rank the relative importance of the main factors.

What potential does school have to improve students' nutrition and exercise knowledge and behavior?

Do you feel that students' nutrition behavior has an impact on their academic performance?

Do you feel that students' exercise behavior has an impact on their academic performance?

Other comments which might be relevant?

1

2

Appendix D - Parent or Guardian Informed Consent Form

(survey was distributed formatted to fit on two sides on one sheet)

[en español al otro lado]

Dear Parent or Guardian:

A researcher at Fielding Graduate University is asking permission for your child to be in a research study on exercise and nutrition education, "Transformative Education for Long-Term Healthy Behavior: In-school Curriculum-based Exercise and Nutrition Programs." The results

of this research will be published in a dissertation and possibly published in subsequent journals or books or presentations.

During the coming year, during part of one class session for about 10-20 minutes, a researcher from Fielding Graduate University will be conducting a research study in your child's classroom. The study helps to assess the long-term impact on students' exercise and nutrition habits of Operation Tone-Up, which some students participated in during elementary school. This study can help to develop programs to improve students' health through better exercise and nutrition knowledge and habits.

The researcher will interact with your child under the supervision of your child's teacher in the classroom. The researcher will be asking all students in the class to complete a brief survey form at their desks about their exercise and nutrition habits. The researcher will then measure your child's heart rate.

Your child's responses will remain confidential. They will not be shared by the researcher with other students or school personnel. Any quotes by students which are used in the study or for publications or presentations will not list your child's name. In addition, no reports about the study will contain your child's name. To help protect your child's health, if your child's blood pressure or resting heart rate is dangerously high or low, the researcher may let the school nurse know, subject to District policies. The researcher will not release any information about your child without your permission.

Taking part is voluntary, students do not have to participate. The information which is collected will not be a part of your child's school record and will not affect his/her grade in any way. All students in the class may complete the survey. If you wish your child to be in this study, please fill out the form at the bottom of this letter and return it to the teacher. If

you do NOT wish your child to participate, please instruct your child to hand in a blank survey form, so that the researcher will not include him/her in the research. In the classroom, the researcher will ask the children to participate, but tell them to hand in a blank survey sheet if they do not want to be included. Your child may choose to stop and not participate in the survey or blood pressure and heart rate measurements at any time without any negative consequences, and you or your child may request that previously provided information be removed from the study.

If you have questions about the study, please contact Scott Turner, Ph.D. student with Fielding Graduate University, under the supervision of Professor Leonard Baca, at 602-513-0028 or email scott.turner.edu@gmail.com. The Institutional Review Board (IRB) of Fielding Graduate University retains the right to access the signed informed consent forms and study documents. If you have questions or concerns about your or your child's rights as a research participant, contact Fielding Graduate University IRB by email at irb@fielding.edu or by telephone at 805-898-4033, or 800-340-1099, extension 4033, or write to Fielding Graduate University, 2112 Santa Barbara Street, Santa Barbara, CA 93105.

Please keep this copy of this informed consent form for your records, and send back only the signed permission form, if you give your permission for your child to participate.

Formulario de Consentimiento Informado para padres o tutores

[*English version overleaf*]

Estimado Padre/Madre/Tutor:

Un investigador de Fielding Graduate University está solicitando autorización para que su niño participe en un estudio de investigación sobre ejercicio y educación nutricional llamado "Educación transformativa para la conducta saludable de largo plazo: Programas de ejercicio y nutrición basados en el currículo escolar". Los resultados de esta investigación se publicarán en una disertación y probablemente aparecerán en sucesivas revistas, libros o presentaciones.

En el correr del año, durante parte de una sesión de clase de 10 a 20 minutos, un investigador de la Fielding Graduate University efectuará un estudio de investigación en el salón de clases de su niño. El estudio ayuda a evaluar el impacto a largo plazo en los hábitos de ejercicio y nutrición de los estudiantes de Operation Tone-Up, un programa en el que algunos estudiantes participaron durante la escuela primaria. Este estudio puede ayudar a desarrollar programas para mejorar la salud de los estudiantes a través de más conocimientos y mejores hábitos de ejercicio y nutrición.

El investigador interactuará con su niño bajo la supervisión del maestro de su niño en el salón de clases. El investigador pedirá a todos los estudiantes en la clase que completen en sus escritorios el formulario de una breve encuesta acerca de sus hábitos de ejercicio y nutrición. El investigador luego medirá el ritmo cardíaco de su niño.

Las respuestas de su niño permanecerán confidenciales. El investigador no compartirá las respuestas con otros estudiantes ni con el personal de la escuela. Cualquier referencia de los estudiantes, que se use en el estudio para publicaciones o presentaciones, no tendrá el nombre de su niño. Además, ningún informe sobre el estudio contendrá el nombre de su niño. Para ayudar a proteger la salud de su niño, si la presión arterial de su niño o el ritmo cardíaco en reposo dan valores peligrosamente altos o bajos, el investigador podría informar al enfermero de la escuela, sujeto a las políticas del Distrito. El investigador no divulgará información alguna sobre su niño sin su autorización.

La participación es voluntaria, los estudiantes no están obligados a participar. La información reunida no será parte de los registros escolares de su niño y no afectará su grado de forma alguna. Todos los estudiantes en la clase pueden completar la encuesta. Si usted quiere que su niño participe en este estudio, por favor complete el formulario al final de esta carta y regréselo al maestro. Si usted NO quiere que su niño participe, por favor instruya a su niño para que entregue un formulario de la encuesta en blanco, y así el investigador no lo incluirá a él o ella en la investigación. En el salón de clases, el investigador pedirá a los niños que participen, pero dígale a su niño o niña que entregue una hoja de la encuesta en blanco si no quiere que sea incluido. Su niño podría elegir dejar de participar en la encuesta o en las mediciones de presión arterial y ritmo cardíaco en

cualquier momento, sin ninguna consecuencia negativa, y usted o su niño podrían pedir que la información provista anteriormente sea removida del estudio.

Si tiene cualquier pregunta sobre el estudio, por favor contacte a Scott Turner, estudiante Ph.D. en la Fielding Graduate University, bajo la supervisión del Profesor Leonard Baca, en el teléfono 602-513-0028 o por email en scott.turner.edu@gmail.com. La Junta Revisora Institucional (IRB) de la Fielding Graduate University retiene el derecho a acceder a los formularios de consentimiento informado y a los documentos del estudio. Si tiene preguntas o inquietudes acerca de sus derechos o los derechos de su niño como participante en una investigación, contacte a la IRB de la Fielding Graduate University por email en irb@fielding.edu o por teléfono en el 805-898-4033 o en el 800-340-1099, extensión 4033, o escriba a la universidad: Fielding Graduate University, 2112 Santa Barbara Street, Santa Barbara, CA 93105.

Por favor conserve esta copia del formulario de consentimiento informado para sus registros, y regrese solo el formulario de permiso firmado, si usted da su permiso para que su niño participe.

Please complete the below information, to confirm that you wish for your child to participate in the research.

I give permission for my child (***write your child's name here***) _____ to be in the research study on exercise and nutrition being conducted in his/her classroom.

Parent's or Guardian's Signature _____ (Date) _____

Please print your name _____

IF YOU **DO NOT WISH** FOR YOUR CHILD TO PARTICIPATE, please print names below:

Print **child's name**, whom you do **NOT** want to participate:

_____

Print **your name**, if you do **NOT** want to participate:

_____

Permiso de padre, madre o tutor para participar

Por favor complete la información de abajo, para confirmar que quiere que su niño participe en la investigación.

Doy autorización para que mi niño (***escriba el nombre de su niño aquí***) _____ participe en el estudio de investigación sobre ejercicio y nutrición que se lleva a cabo en su salón de clases.

Firma del padre, madre o tutor _____ (Fecha) _____

Por favor escriba su nombre con letra de molde _____

SI **NO QUIERE** QUE SU NIÑO PARTICIPE, por favor escriba abajo con letra de molde los nombres:

Escriba con letra de molde el **nombre del niño**, que usted **NO** quiere que participe: _____

Escriba con letra de molde **su nombre**, si usted **NO** quiere participar:_____

Appendix E - Employee Informed Consent Form for Interview

Dear Teacher or Other School District Employee:

I, Scott Turner, a researcher at Fielding Graduate University, am asking your permission for your responses to be used as part of a research study, "Transformative Education for Long-Term Healthy Behavior: In-school Curriculum-based Exercise and Nutrition Programs." The results of this research will be published in a dissertation and possibly published in subsequent journals or books or presentations.

During the coming year, during part of a class session for approximately 10-20 minutes, I will be conducting a research study in classrooms. The study helps to assess the long-term impact of Operation Tone-Up, which some students participated in during elementary school, on students' exercise and nutrition habits. This study can help to develop programs to improve students' health through better exercise and nutrition knowledge and habits.

I will interact with students under the supervision of the child's teacher in the classroom. I will be asking students to complete a brief survey form at their desks. I will then take their blood pressure and heart rate measurement.

I am interviewing school personnel who can help me understand other possible influences on students' exercise and nutrition knowledge and behavior, besides Operation Tone-Up. This information will allow me to understand and compensate for other factors impacting students' understanding and habits, in the years during and after Operation Tone-Up was offered in elementary schools in this area.

Your responses will remain confidential. They will not be shared by researchers with students or other school personnel, and you will not be referred to by name, title or in other ways which allow you to be identified, in reports based on this research. Any quotes by you or other participants which are used in the study or for publications or presentations will not list your name. In addition, no reports about the study will contain your name. I will not release any information about your responses without your permission.

Taking part is voluntary. If you wish to be in this study, which means that your responses may be included confidentially in the research data, please fill out the form at the bottom of this letter and return it to Scott Turner. You may choose to stop and not continue to participate in the interview at any time without any negative consequences, you may choose not to answer particular questions, and you may request that previously provided information be removed from the study.

If you have questions about the study, please contact me, Scott Turner, Ph.D. student with Fielding Graduate University, under the supervision of Professor Leonard Baca, at 602-513-0028 or email scott.turner.edu@gmail.com. The Institutional Review Board of Fielding Graduate University retains the right to access the signed informed consent forms and study documents. If you have questions or concerns about your rights as a research participant, contact the Fielding Graduate University IRB by email at

irb@fielding.edu or by telephone at 805-898-4033, or at 800-340-1099, extension 4033, or write to Fielding Graduate University, 2112 Santa Barbara Street, Santa Barbara, CA 93105.

A photocopy of this informed consent form will be provided to you.

Participant's Signature _____ (Date) _____

Name (please print) _____

Title _____ School/School District/Dept.

_____

Appendix F - Request for Permission to Conduct Research

Scott Turner
5711 N. Echo Canyon Circle
Phoenix, AZ 85018
scott.turner.edu@gmail.com
tel 602-513-0028

[Date], 2012

[Name]
[Title]
[School/District]
[Address]
[City, AZ Zip Code]
[Via U.S. Mail or Email]

Subject: Research Study through Fielding Graduate University

Dear [Name],

I would like to request permission to conduct research at your school as part of a research study through Fielding Graduate University. The title of the study is "Transformative Education for Long-Term Healthy Behavior: In-school Curriculum-based Exercise and Nutrition Programs." The results of this research will be published in a doctoral dissertation and possibly published in subsequent journals or books or presentations.

During the coming year, during part of one class session for about 10-20 minutes, researchers from Fielding Graduate University would like to conduct a research study in approximately 5-10 classrooms. The study helps to assess the long-term impact on students' exercise and nutrition habits of Operation Tone-Up, which some students participated in during elementary school. This study can help to develop programs to improve students' health through better exercise and nutrition knowledge and habits. In addition, recent academic research indicates a possible link between exercise and nutrition and academic performance. So by improving school-based exercise and nutrition education, schools may be able to improve academic success.

We will interact with students under the supervision of the teacher in the classroom. We will be asking all students in the class to complete a brief survey form at their desks about their exercise and nutrition habits. We will then take their blood pressure and heart rate measurements using a simple armband that many people use at home or in the doctor's office. The device armband is wrapped around the student's arm for a minute or two, as when

they get their blood pressure checked by a nurse or doctor, and the monitor automatically checks their blood pressure and heart rate. It doesn't hurt at all, students just feel a little pressure from pumped air around their arm, as is typical with blood pressure measurement.

Students' responses will of course remain confidential. They will not be shared by researchers with other students or school personnel. In addition, no reports about the study will contain children's names. We will not release any information about children without parental permission.

We are providing an informed parental consent form for distribution to parents, using whatever means your school prefers. Parents may inform the school by signing and returning the form, if they wish to have their child participate in the study. This informed consent (IC) form notes that taking part is voluntary, students do not have to participate.

In addition, we are planning on interviewing approximately 3-5 teachers and other school personnel to understand other factors in school, which may have influenced students' exercise and nutrition knowledge and habits. We are doing this in order to minimize the impact of "confounding variables" on our research. We are providing school personnel who participate voluntarily in these interviews with an informed consent form. This IC form explains the research and their rights in the research, including protection of their privacy and the confidentiality of their responses.

Copies of both informed consent forms are attached to this letter.

If you have questions about the study, please contact Scott Turner, Ph.D. student with Fielding Graduate University, under the supervision of Professor Leonard Baca, at 602-513-0028 or email scott.turner.edu@gmail.com. The Institutional Review Board of Fielding Graduate University retains the right to access the signed informed consent forms and study documents. If you have questions or concerns about your or students' rights as a research participant, contact the Fielding Graduate University IRB by email at irb@fielding.edu or by telephone at 805-898-4033, or at 800-340-1099, extension 4033, or write to Fielding Graduate University, 2112 Santa Barbara Street, Santa Barbara, CA 93105.

Thank you very much for your assistance with this research study on in-school exercise and nutrition education. I believe that our work in this area will make a contribution to improving exercise and nutrition education in schools, and ultimately, indirectly, to academic performance.

If you would like a copy of my dissertation, when it is finalized, approved, and available for release, please let me know. Again, my email address is scott.turner.edu@gmail.com, and my phone is 602-513-0028, or you can reach me at my address: 5711 N. Echo Canyon Circle, Phoenix, AZ 85018.

Sincerely,
[Signature]

Appendix G - Thank You Letter after Conducting Research

Scott Turner
5711 N. Echo Canyon Circle
Phoenix, AZ 85018
scott.turner.edu@gmail.com
tel 602-513-0028

[Date], 2012

[Name]
[Address]
[City, AZ Zip Code]

[Via U.S. Mail or Email]

Subject: Research Study with Fielding Graduate University

Dear [Name],

Thank you very much for your assistance with the research study on in-school exercise and nutrition education, which I am conducting through Fielding Graduate University.

Your assistance was an important part of this research.

I believe that our work in this area will make a contribution to improving exercise and nutrition education in schools.

In addition, academic research increasingly shows a link between exercise, nutrition, and academic performance, so we have an opportunity to improve academic success as well as instilling healthy habits.

If you would like a copy of my dissertation, when it is finalized, approved, and available for release, please let me know. My email address is scott.turner.edu@gmail.com, and my phone is 602-513-0028, or you can reach me at the above address.

Sincerely,

[Signature]
Scott Turner

Appendix H - Request for Permission to Use Archival Intervention-related Data

Email from Tony Lamka, Executive Director, Accept The Challenge, and Creator & Operator of Operation Tone-Up®, dated January 25, 2012

OTU PERMISSION

tony tony@operationtoneup.com

12:26 PM (33 minutes ago)

I give Scott Turner permission to use Operation Tone-Up archival data as part of his dissertation research.

Should you need to contact me directly, please call: 602.432.2898.

Sincerely,

Tony Lamka
Executive Director
tony@operationtoneup.com
602.432.2898
www.operationtoneup.com