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Cognitive-Behavioral Health-Promotion Intervention Increases Fruit and Vegetable Consumption and Physical Activity among South African Adolescents: A Cluster-Randomized Controlled Trial

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Abstract

Rates of chronic diseases are high among Black South Africans. Few studies have tested cognitive-behavioral health-promotion interventions to reduce chronic diseases in South Africa. We tested the efficacy of such an intervention among adolescents in a cluster-randomized controlled trial. We randomly selected 9 of 17 matched-pairs of schools and randomized one

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school in each pair to the cognitive-behavioral health-promotion intervention designed to encourage health-related behaviors and the other to a HIV/STD risk-reduction intervention that served as the control. Interventions were based on social cognitive theory, the theory of planned behavior, and qualitative data from the target population. Data collectors, blind to participants' intervention, administered confidential assessments at baseline and 3, 6, and 12 months post-intervention. Primary outcomes were fruit and vegetable consumption and physical activity. Participants were 1,057 grade 6 learners (mean age = 12.4 years), with 96.7% retained at 12-month follow-up. Generalized estimating equations revealed that averaged over the follow-ups, a greater percentage of health-promotion intervention participants than HIV/STD control participants met 5-a-Day fruit and vegetable and physical activity guidelines. The intervention also increased health-promotion knowledge, attitude, and intention, but did not decrease substance use or substance-use attitude and intention. The findings suggest that theory-based, contextually appropriate interventions may increase health behaviors among young adolescents in sub-Saharan Africa.

Keywords

Theory of planned behavior; interventional studies; health promotion; health behavior; fruit; vegetable; exercise

INTRODUCTION

That behavior can influence health for good or ill is well documented and widely accepted (US National Research Council, 1989; World Health Organization, 2003). However, there is a substantial gap between the knowledge that behavior affects health and the practice of health-enhancing behaviors. In the United States and other developed countries, considerable progress has been made in closing this gap. Numerous behavior change interventions have been developed, implemented, and evaluated in rigorous clinical trials (e.g., Godin, Valois, Lepage, & Desharnais, 1992; Morgan & Grube, 1994). In contrast, in developing countries much less progress has been made (Temple, 2007). Yet, the burden from preventable diseases has been increasing in the developing world, particularly as progress is made in economic development.

In South Africa, for instance, a large portion of the morbidity and mortality each year can be attributed to health-related behaviors, including cigarette smoking, alcohol abuse, inadequate fruit and vegetable consumption, and physical inactivity, or to conditions influenced by behaviors, including obesity and hypertension (Joubert, Norman, Lambert, et al., 2007; Norman et al., 2007; Schneider et al., 2007). Several studies suggest that the rates of obesity and diabetes are increasing in South Africa, particularly among Black South Africans (Schutte & Olckers, 2007).

A considerable amount of attention has been given to the HIV/AIDS epidemic in sub-Saharan Africa (UNAIDS, 2006). Surprisingly, given the significant relationship that exists between health and HIV, limited attention has been given to health promotion more generally in sub-Saharan Africa (Temple, 2007). This is particularly so with regard to children and young adolescents. To gain a broad based national picture of the prevalence of

health-related behavior among South African high school learners, the South African National Department of Health conducted the first South African Youth Risk Behaviour Survey in 2002 (Reddy et al., 2003). More than one third (37.5%) of the respondents engaged in insufficient physical activity (Amosun, Reddy, Kambaran, & Omardien, 2007). A significantly higher percentage of black (37.5%) and coloured learners (45.6%) than white learners (29.4%) engaged in insufficient physical activity. Considering that children under the age of 19 years make up about one-half of the South African population (Statistics South Africa, 2003), with approximately 12 million children enrolled in school, an efficacious school-based intervention has the potential to impact on the health of the nation. By reaching people when they are young, it is possible to teach them health-enhancing habits before they establish unhealthy habits resistant to change.

This article reports the results of a study that tested a school-based cognitive-behavioral health-promotion intervention for Xhosa-speaking young adolescents in South Africa. We sought to develop, deliver, and test an intervention that might improve the lifelong health of South African adolescents by increasing positive health behaviors, including fruit and vegetable intake and physical activity, and decreasing the initiation of negative health behaviors, including smoking and alcohol use. In designing the intervention, we drew upon social cognitive theory and the theory of planned behavior (Ajzen, 1985, 1991) as our theoretical framework. According to the theory of planned behavior, behavioral intentions are the determinants of behaviors, and intentions are determined by attitude, subjective norm, and perceived behavioral control or self-efficacy regarding the behavior.

Certain features of the theory of planned behavior make it an excellent choice for use in South Africa. The theory is flexible in that it allows diversity to be taken into account. It can be adapted to explain different classes of behaviors and to apply to different populations. An example of this flexibility is that the theory explicitly states that the relative predictive power of attitude, subjective norm, and self-efficacy may vary depending on the behavior and the population. A valuable feature of the theory of planned behavior is that it directs attention to *why* people hold specific attitudes, subjective norms, and self-efficacy. Behavioral beliefs about the consequences of the behavior determine attitude toward the behavior. Normative beliefs about important referents' approval or disapproval of the behavior determine subjective norm. Control beliefs about factors that facilitate or inhibit the behavior determine self-efficacy.

Further, the theory holds that the salient beliefs can be identified through formative research conducted on the population. Accordingly, we conducted extensive formative research, including focus groups, interviews, and surveys. By integrating the qualitative information from the formative research with the theoretical framework, it was possible to develop an intervention that was both theory-based and contextually appropriate for the population. This approach resulted in a culturally appropriate intervention, linguistically matched to our target population that was delivered in the local language, Xhosa.

The study utilized a cluster-randomized controlled trial and was conducted in both urban and rural schools in the Eastern Cape Province of South Africa. Nine pairs of schools were randomly selected to participate in the trial, and one school in each pair was randomized to

the cognitive-behavioral health-promotion intervention designed to encourage healthful behavior or a HIV/STD risk-reduction intervention that served as the control. Grade six learners who participated in the interventions completed self-report questionnaires before the intervention and 3, 6, and 12 months post-intervention. We hypothesized that the health-promotion intervention would increase (a) the proportion of learners consuming 5 or more servings of fruits and vegetables each day and (b) the proportion of learners who engage in vigorous physical activity for 20 minutes or more on 4 or more days a week or moderate physical activity for 30 minutes or more on 5 or more days a week and engage in strength-building physical activity on 2 or more days a week, as compared with the HIV/STD control intervention.

Methods

The Institutional Review Board (IRB) #8 at the University of Pennsylvania, which was the designated IRB under the federalwide assurances of the University of Pennsylvania and the University of Fort Hare, reviewed and approved the study. The IRB at the Centers for Disease Control and Prevention (CDC) deferred approval to the IRB at University of Pennsylvania. The study was conducted in Mdantsane, an urban township, and Berlin a neighboring rural settlement, in Eastern Cape Province, South Africa. Schools that taught grade six learners and served the general population of learners were eligible to participate. There were 36 primary schools in Mdantsane and Berlin. One school for children with learning disabilities was ineligible, leaving 35 eligible schools: 26 in Mdantsane and 9 in Berlin. All 35 eligible schools agreed to participate in the trial. We created 17 matched pairs of schools that had similar numbers of grade six learners, classrooms, and classrooms with electricity—a proxy for poverty. Specifically, in a spreadsheet we sorted the schools on numbers of grade six learners, classrooms, and classrooms with electricity and created pairs from schools that were adjacent in the resulting list. We matched urban and rural schools separately. Because there were 9 rural schools one “pair” consisted of 3 schools. From the 17 matched pairs, we randomly selected 9 pairs: 7 pairs comprised of urban schools and 2 comprised of rural schools.

We utilized a cluster-randomized controlled trial design. Within each pair, using computer-generated random number sequences, we randomized one school to the cognitive-behavioral health-promotion intervention and the other to the HIV/STD risk-reduction control intervention using concealment of allocation techniques, which were designed to minimize bias in assignment in randomized clinical trials. The biostatistician in Philadelphia conducted the computer-generated random assignments, and the project director in East London, South Africa, implemented the assignments. We enrolled into the trial learners from the 18 schools over a 13-month period beginning in October 2004. Based on our schedule of interventions and the school-year calendar, we divided the nine matched-pairs into three groups and conducted interventions sequentially. Pairs 1–3 received the interventions in October and November 2004; pairs 4–6 received the interventions in January, February, and March 2005; and pairs 7–9 in October and November 2005. All data collection was completed by December 2006.

To recruit participants, recruiters made announcements to all grade six learners at the selected schools and distributed letters to parents or guardians. Recruiters followed a common standardized scripted recruitment procedure at all schools, and recruiters, school administrators, and potential participants were blind to the intervention to which the school had been randomized. Grade six learners who provided written assent and had written parent or guardian consent were eligible to participate. At 12 of the schools, assent and parent or guardian consent were the only eligibility criteria; at 6 schools, there was one additional eligibility criterion: random selection. These six schools had too few classrooms to accommodate all learners who wanted to participate; therefore, at each school we used a computer-generated random number sequence to randomly select a subset of learners as eligible from among all learners with parent or guardian consent.

We held the intervention and data-collection sessions at the learners' schools during the extracurricular period at the end of the school day. Learners completed confidential questionnaires before and 3, 6, and 12 months after the intervention. Learners who completed the pre-intervention questionnaire and attended Session 1 of the intervention were enrolled into the trial. The participants were offered a notebook, a pen, and a pencil for participating in the post-intervention assessment; a notebook, a pen, and a pencil for the 3-month follow-up; a t-shirt displaying the project logo for the 6-month follow-up; and a backpack displaying the logo for the 12-month follow-up.

The Health-Promotion and HIV/STD Risk-Reduction Interventions

The interventions were developed based on extensive formative research or "targeted ethnography" (Wainberg et al., 2007). We conducted nine focus groups with 89 Xhosa-speaking grade six learners, four focus groups with 34 parents of grade six Xhosa-speaking learners, and one focus group with 12 teachers of such learners in Mdantsane and Berlin. Two trained facilitators, one of whom spoke both English and Xhosa, conducted the focus groups. A note taker recorded verbal and non-verbal observations of the participants. Focus groups were also audiotaped. English and Xhosa-speaking transcribers transcribed all audiotapes. The project name, generated by adolescents during this process, was "Masikhusele iKamva Lethu" or "Let Us Protect Our Future." The project logo was a traditional shield and the six main characters from the specially designed comic workbooks we employed in the interventions.

Both interventions consisted of 12 1-hour modules, with 2 modules delivered during each of six sessions on six consecutive school days. Each intervention was highly structured and implemented in mixed-gender groups of about 16 participants by male and female adult Xhosa-speaking co-facilitator pairs who used standardized intervention manuals. We conducted three pilot tests of the interventions with 116 grade six learners: The interventions were pilot tested in English in Mdantsane, translated into Xhosa, back-translated from Xhosa to English, pilot tested in Xhosa in Mdantsane and Berlin, and delivered in Xhosa in the main trial. Both interventions included interactive exercises, games, brainstorming, role-playing, and group discussions. The mixed-gender groups allowed inclusion of single-gender activities led by the same-gender facilitators. Video, which is an often-used strategy in efficacious interventions, could not be used because electricity was not available in many

of the classrooms. We, therefore, employed specially designed comic workbooks—six issues, one for each session—with a series of characters and storylines to address issues that we learned during the formative research phase were important aspects of participants' lives and relevant to the targeted behaviors.

We designed the health-promotion intervention to increase knowledge, attitudes, self-efficacy, and skills to practice healthful behavior, including fruit and vegetable consumption, physical activity, and abstaining from cigarette smoking and alcohol use. These behaviors are associated with risk of heart disease, diabetes, high blood pressure, and certain cancers—leading causes of morbidity and mortality among South Africans (Alberts et al., 2005; Asfaw, 2006; Motala et al., 2008; Steyn et al., 2006; Steyn et al., 2008). Participants were taught that these health problems are related to their behavior—what people do or don't do—and therefore can be prevented by engaging in healthful behaviors.

One of the activities provided the participants an opportunity to think about their goals for the future and understand that their present behavior will have an impact on what they will be doing 5 and 10 years later. Comic workbook storylines were used to increase awareness of health risks. The intervention contained activities to highlight the relation between diet and health, to help participants assess their nutritional habits, and to teach them healthful nutritional practices using the South Africa Dietary Guidelines. It also contained activities on the nutritional value of a variety of foods and the health effects of those nutrients. In one activity, food cutouts were used to construct nutritious meals in accordance with the food pyramid guidelines. A review game, "Spin the Bottle," was used to reinforce all the information the participants learned about nutrition. We employed homework assignments to involve parents or caregivers in the interventions, to enlist their help in empowering their children to reduce their health risks and to ensure that parents were aware of the nature of the interventions. In one homework assignment, participants talked to their parent about a favorite recipe, brought it in, and then discussed how it could be made more healthful.

In other activities, participants considered the physical exercises in which they engaged. They learned about the benefits of three types of exercises: (a) aerobic, defined as exercises that increase the ability of the heart, lungs, and systems of blood vessels to supply oxygen and nutrients to the body to move farther, and longer, with less effort; (b) strength-building, defined as exercises that build muscle; and (c) flexibility-increasing defined as exercises that increase the ability to move around easily and safely through a range of motion. They exercised to upbeat South African music and examined the effects of exercise on their heart by monitoring their pulse before and after exercise. There were also activities that addressed different types of cancer and outlined health habits that can prevent them. Activities revolved around attitudes about cigarette smoking and the health effects of cigarette smoking. Participants considered why adolescents use alcohol and drugs and the adverse health effects of alcohol and drug use and played the lively competitive game "Health Jeopardy," which was designed to reinforce their health knowledge. In this game, the group was split into two teams. The teams selected questions from the game board posted on the wall and earned points for correctly answering questions that fell in several categories (e.g., nutrition, exercise, alcohol) and had different point values. The team that accumulated the most points was declared the winner.

Physical changes of puberty and the basic hygiene needs of male and female adolescents were discussed in single-gender activities led by the same-gender facilitator. Other activities addressed dental health, breast cancer and testicular cancer self-examination, pedestrian safety, and first aid. A "Yarn Ball Activity" was designed to provide participants with closure to the intervention sessions, an opportunity to reflect and share their thoughts regarding the intervention, and to reinforce the sense of having been involved in a special collective experience. They were encouraged to make a commitment to healthful behavior as the co-facilitators gave each participant a certificate of completion.

The HIV/STD risk-reduction intervention (Jemmott & Jemmott, in press) was designed to increase knowledge, attitude, self-efficacy, and skills to practice abstinence and to use condoms, if the adolescents were to have sex. It provides a control for nonspecific features, including group interaction and special attention (Cook & Campbell, 1979). It contained the same number of sessions as the health promotion intervention with similar activities, including the comic workbooks, homework assignments, and an equal number of single-gender modules, implemented by similar co-facilitators. However, it focused on behaviors linked to risk of sexually transmitted diseases, including HIV, which are especially important sources of morbidity and mortality among South Africans (UNAIDS, 2006). It was designed to reduce unprotected sexual intercourse, delay sexual involvement, increase abstinence, and reduce the incidence of multiple sexual partners. The efficacy of the HIV/STD risk reduction intervention is reported in a separate article (Jemmott et al., 2010). A more detailed description of the intervention is available at www.xxxxxx and materials and measures used in this study are available from the first author.

Facilitators and facilitator training—The co-facilitators were 43 adults (21 women and 22 men) 27 to 56 years of age (mean = 42 years) from the community who were bilingual in English and Xhosa. Selected on the basis of oral and performance-based interviewing, their median education was a Bachelor's degree; 65% had worked as teachers. After stratifying them by gender, age, teaching experience, and HIV teaching experience, we *randomly* assigned them to be trained to implement one of the two interventions. In this way, we randomized facilitators' characteristics across interventions (Jemmott, Jemmott, & Fong, 1998).

The facilitators received eight days of training. During the training, the trainers modeled the intervention activities and the facilitators learned their assigned intervention, practiced implementing it, received feedback from each other, the trainers, and the investigators, and created common responses to potential issues that might arise during implementation. The importance of fidelity to the intervention was emphasized.

Assessments

Assessments were conducted before and 3, 6, and 12 months post-intervention via confidential questionnaires that were written in Xhosa following translation and back-translation from English. Adults from the community who were bilingual in Xhosa and English and who were blind to the participants' intervention assignment collected the data using a read-aloud procedure: Learners completed questionnaires at their desks while the

data collectors read the questions aloud. Before collecting data, data collectors received two full days of training that included modeling of data-collection procedures and mock data collection with feedback from the trainers and investigators. The baseline questionnaire was pilot tested with 64 grade six learners from Mdantsane and Berlin before we employed it in the trial.

A seven-item food frequency questionnaire developed by the National Cancer Institute to evaluate 5-a-Day studies was used to measure fruit and vegetable consumption over the past 30 days (Thompson, Byers, & Kohlmeier, 1994). The items concerned 100% orange or grapefruit juice, other 100% juices, fruit, green salad, fried potatoes, other potatoes, and other vegetables (e.g., In the past month [30 days], about how often did you drink 100% orange juice or grapefruit juice? with 8 categories from Did not drink 100% orange or grapefruit juice in the past month to 5 or more times per day). Total consumption was computed by summing individual item scores (Campbell et al., 1999). A binary outcome was calculated indicating whether or not the participant met the 5-a-Day guideline of eating at least five servings of fruit and vegetables daily in the past 30 days.

Physical activity was assessed with three open-ended items developed by the CDC: On how many of the past 7 days, did you exercise or participate in physical activity for at least 20 minutes that made you sweat and breathe hard, such as basketball, soccer, running, jumping rope, or similar vigorous physical activities? On how many of the past 7 days, did you exercise or participate in physical activity for at least 30 minutes that did not make you sweat and breathe hard, such as walking or anything else that caused small increases in breathing or heart rate? On how many of the past 7 days, did you do push-ups or sit-ups? A binary outcome was calculated indicating whether or not the participant met the physical activity guideline. Participants were defined as meeting the guideline if they engage in strength-building activity (i.e., push-ups or sit-ups) on 2 days *and* engaged in either 20 minutes of vigorous activity on at least 4 days or 30 minutes of moderate activity on at least 5 days. Participants also reported the number of days in the past 30 days that they smoked cigarettes, drank alcohol, binged (had five or more drinks on an occasion), and used dagga (marijuana).

We took several steps to increase the validity of self-reported behavior. To facilitate the learners' ability to recall, we asked them to report their behaviors over brief periods, wrote the dates comprising the period on a chalkboard, and gave them calendars clearly highlighting the period. We stressed the importance of responding honestly, informing them that their responses would be used to create programs for other Xhosa-speaking adolescents like themselves and that we could do so only if they answered the questions honestly. We assured the participants that their responses would be kept confidential and that code numbers rather than names would be used on the questionnaires. Participants signed an "agreement" pledging to answer the questions honestly, a procedure that has been shown to yield more valid self-reports on sensitive issues (Sudman & Bradburn, 1974).

Participants completed measures of theoretical mediator variables. Health-promoting-behavior attitude and intention and drug-and-alcohol-use attitude and intention were assessed on five-point rating scales. The average of three items concerning attitude toward

exercising (e.g., How do you feel about exercising for 30 minutes at least 6 times a week in the next 3 months?), eating five or more servings of fruit and vegetables, and decreasing fat in diet measured health-promoting-behavior attitude (Cronbach's alpha = 0.65). The average of three items concerning these same behaviors (e.g., How likely is it that you will exercise for 30 minutes at least 6 times a week in the next 3 months?) measured health-promoting-behavior intention (alpha = 0.67). The average of three items concerning smoking cigarettes (e.g., How do you feel about smoking cigarettes in the next 3 months?), drinking alcohol, and smoking dagga (marijuana) measured attitude toward using drugs and alcohol (alpha = 0.75). The average of three parallel items (e.g., How likely is it that you will smoke cigarettes in the next 3 months?) measured the intention to use drugs and alcohol (alpha = 0.79). Health-promotion knowledge was the number correct out of 21 true-false items concerning cigarette smoking, physical activity, nutrition, alcohol and drug use, and dental health (e.g., Physical exercise that make you sweat and breathe hard are the best exercises to strengthen your heart).

Participants also completed measures of sexual risk behaviors and potential mediators of sexual risk behaviors, including intention, attitude, subjective norm, self-efficacy, and beliefs, to permit evaluation of the efficacy of the HIV/STD risk-reduction intervention. These measures preceded the measures related to the health promotion intervention in the questionnaire.

Statistical Analyses

We used chi-square tests to analyze differences between participants and eligible non-participants on gender. We used chi-square and *t* tests to analyze attrition. The efficacy of the health-promotion intervention as compared with the HIV/STD control intervention over the 3-, 6-, and 12-month follow-ups was tested using generalized estimating equation (GEE) models, properly adjusting for nested longitudinal repeated measurements on participants within schools (Fitzmaurice, Laird, & Ware, 2004; Liang & Zeger, 1986). This analytic strategy accounted for the correlation among participants within schools assessed longitudinally. The models were fit and estimate statements were specified to obtain odds ratios for binary measures, mean differences for continuous measures, and corresponding 95% confidence intervals. Effect sizes for continuous measures were constructed by averaging time-specific effects constructed at the 3-, 6-, and 12-month follow-ups. Robust standard errors were employed and an independent working correlation matrix was specified. The models included time-independent covariates, baseline measure of the criterion, intervention condition, pair (nine categories representing nine matched-pairs), and time (three categories representing 3-, 6-, 12-month follow-up). As a standardized measure of effect size Cohen's *d* was calculated using the Cox method (Sanchez-Meca, Marin-Martinez, & Chacon-Moscoso, 2003) for odds ratios and the z test statistic and N from the GEE analysis for continuous variables. Models assessing whether the efficacy of the intervention differed among the three follow-ups included the baseline measure of the criterion, intervention condition, pair, time, and the Intervention-Condition x Time interaction. Intention-to-treat analyses were performed so that participants were included on the basis of their intervention assignment, regardless of the number of intervention or data-

collection sessions attended. All analyses were completed using SAS V9. Hypotheses were tested with two-sided tests using significance criterion $p < 0.05$.

Role of the Funding Source

The sponsors of the study had no role in study design, data collection, data analysis, data interpretation, or the writing of the report.

Results

Of the 1,118 grade six learners who were eligible, 1,057 or 94.5% participated. A higher percentage of eligible girls (558/575 or 97.0%) as compared with boys (499/543 or 91.9%) participated, $p = 0.0002$. Table 1 shows that 18 schools and 1,057 grade six learners, 558 girls and 499 boys, entered the trial. The learners' age ranged from 9 to 18 years, with a mean of 12.4 years (SD = 1.2). About 7.6% resided in the rural area of Berlin, and the others lived in the urban township of Mdantsane. Only 38.8% lived in a household with their father.

All 18 participating schools remained in the trial to its completion. Attendance at intervention sessions was high. All participants attended intervention session 1, and attendance at sessions 2 through 6 ranged from 97.0% to 98.6%. Follow-up return rates were excellent: 1,029 (97.4%) completed the 3-month follow-up, 1,030 (97.4%) completed the 6-month follow-up, and 1,022 (96.7%) completed the 12-month follow-up. Of the randomized 1,057 participants, 1,043 (98.7%) attended at least one of the three follow-ups. The percentage that attended at least one follow-up did not differ in the health-promotion intervention (98.6%) and the HIV/STD control condition (98.8%). Attending a follow-up session was unrelated to gender, their father's presence in their households, residing in the rural settlement, and health behaviors with two exceptions. Those who returned follow-up reported more moderate exercise in the 7 days before baseline than did those who did not return (Means = 0.24 versus 0.00, $p = 0.04$). Those who reported smoking cigarettes in the 30 days before baseline (93.6%) were less likely to return for follow-up than those who did not report such smoking (98.8%), $p = 0.01$. In addition, participants 14 to 18 years of age (96.0%) were less likely to return for follow-up than were those 12 to 13 years (99.2%) and 9 to 11 years (99.2%), $p = 0.003$.

Effects of the Health-Promotion Intervention

Primary Outcomes—Table 2 presents descriptive statistics for health behaviors and theoretical mediators by intervention condition and assessment period. Table 3 presents significance tests for the intervention effect averaged over three follow-up assessments unadjusted for baseline and adjusted for baseline. The health-promotion intervention significantly increased the percentage of participants who met the 5-a-Day guideline. Participants in the health promotion intervention were significantly more likely to have met the 5-a-Day guideline in the past 30 days, compared to participants in the HIV/STD risk reduction intervention, adjusted for baseline response (odds ratio = 1.30, $p = 0.008$). Participants in the health-promotion intervention (reported eating approximately 0.54 more servings of fruit ($p = 0.003$) over follow-up. In addition, health-promotion intervention

participants reported eating 0.77 more servings of vegetables ($p = 0.0001$) over follow-up. These estimated differences in consumed servings are consistent with estimated effect sizes of 0.19 and 0.24 for fruit and vegetables, respectively.

Participants in the health promotion intervention were significantly more likely to have met the physical activity guideline in the past 7 days (odds ratio = 1.56, $p<0.0001$) over the 3-, 6-, and 12-month follow-ups. The health-promotion intervention participants, as compared with HIV/STD control participants, reported 0.44 more days on which they had intensive cardiovascular physical activity ($p < 0.0001$), 0.67 more days of moderate cardiovascular physical activity ($p < 0.0001$), and 0.35 more days of strength-building physical activity ($p = 0.0006$). These estimated mean differences are equal to effect sizes of 0.33, 0.43, and 0.22 for intensive, moderate, and strength-building physical activity estimates, respectively.

Secondary Outcomes—As shown in Table 2, only a small percentage of participants reported substance use during the study period. There were no significant effects of the health-promotion intervention on smoking cigarettes, drinking alcohol, or binge drinking over the follow-up period. Too few participants reported smoking dagga to permit analysis.

The health promotion intervention had significant effects on the mediators of fruit and vegetable consumption and physical activity. Participants in the health-promotion intervention scored on average 2.54 points higher in health-promotion knowledge ($p < 0.0001$) than participants in the control group. Health-promotion intervention participants also expressed a more favorable attitude toward health-promoting behavior (Mean difference = 0.43, $p < 0.0001$) and a firmer intention to engage in such behavior (Mean difference = 0.45, $p < 0.0001$) than did their counterparts in the HIV/STD control group. These estimates correspond to effect sizes equal to 1.03, 0.89, and 0.81 for health-promotion knowledge, attitudes toward health promoting behavior, and intentions to engage in such behavior. The two interventions did not differ on attitude or intention related to using drugs and alcohol.

Gender Variations in Efficacy—Gender x Intervention-Condition interactions were employed to examine possible gender moderated intervention effects, adjusting for baseline criterion. The intervention effect on reported fruit consumption was significantly different in boys and girls ($p = 0.0385$). Specifically, boys randomized to the health promotion intervention reported consuming 0.95 more servings of fruit over the follow-up than did their male counterparts in the control arm. The estimated differences for girls randomized to the health promotion intervention, compared to girls randomized to the HIV/STD risk-reduction control intervention was not as large (0.20). There were no other intervention effects that were significantly modified by gender.

Age Group Variations in Efficacy—Age group x Intervention-Condition interactions were employed in order to examine possible age group moderated intervention effects, adjusting for baseline criterion. There were no observed intervention effects that varied by age group.

Variations in Efficacy among Follow-up Assessments—The Intervention-Condition x Time interaction was not significant for the 5-a-Day guideline, self-reported vegetable consumption, cigarette smoking, alcohol consumption, or binge drinking. However, this interaction was significant for self-reported fruit consumption indicating that the health-promotion intervention had a stronger effect at the 3-month follow-up than the 12-month follow-up ($p = 0.001$). It was also significant for (a) the physical activity guideline, indicating that the health-promotion intervention had a stronger effect at the 3-month follow-up than at the 6-month ($p = 0.002$) or 12-month follow-up ($p = 0.001$), (b) self-reported vigorous cardiovascular physical activity, indicating that the health-promotion intervention had a stronger effect at the 3-month follow-up than at the 6-month ($p < 0.0001$) or 12-month follow-up ($p = 0.007$), (c) self-reported moderate cardiovascular physical activity, indicating that the health-promotion intervention had a stronger effect at the 3-month follow-up than at the 6-month follow-up ($p = 0.01$), and (d) self-reported strength-building physical activity, indicating that the health-promotion intervention had a stronger effect at the 3-month follow-up than at the 6-month ($p = 0.01$) or 12-month follow-up ($p = 0.0002$). The interaction was also significant on health-promotion mediators. It had a stronger effect on health-promotion knowledge ($p = 0.0002$), attitude ($p = 0.0002$), and intention ($p = 0.01$) at the 3-month follow-up than at the 12-month follow-up.

No adverse responses to the intervention or control manipulations were observed..

Discussion

The results of this trial indicate that a cognitive-behavioral, contextually appropriate health-promotion intervention delivered in schools can be effective in shaping the health behavior of young South African adolescents. The Eastern Cape Province of South Africa is a setting where such an intervention is needed urgently to thwart the adverse effects of the transition to an increased intake of fat, saturated fat, and sugar in the diet that is occurring with the rapid urbanization of the Black population (Schutte & Olckers, 2007; Steyn et al., 2006; Temple, 2007). Averaged over the three follow-ups, the health-promotion intervention increased the percentage of adolescents who reported adhering to the 5-a-Day guidelines. The adolescents increased their fruit and vegetable consumption by about 1.3 servings per day compared with the control group. Although we observed increases in both fruit and vegetable consumption, most of this increase was in consumption of vegetables (0.77) rather than fruit (0.52).

The health-promotion intervention also increased the percentage of adolescents who reported adhering to the physical activity guidelines in the past 7 days. Although the health-promotion intervention participants increased both their vigorous cardiovascular physical activity and strength-building physical activity, the largest increase was in moderate cardiovascular physical activity, which increased by approximately three-quarters of a day. Paralleling the intervention-induced increases in fruit and vegetable consumption and physical activity were increases in health-promotion knowledge, attitude, and intention.

Although the health-promotion intervention had strong effects averaged over the 3 follow-ups, its efficacy also varied among three follow-up assessment periods. The effects of the

intervention were strongest at the 3-month follow-up as compared with the later follow-ups, particularly the 12-month follow-up. This may mean there are limits to the efficacy of a one-time intervention. Additional intervention sessions may be required to sustain efficacy. In contrast to the significant effects on adherence to the 5-a-Day and physical activity guidelines, the intervention did not influence cigarette smoking, alcohol use, or dagga use or attitude and intention for these behaviors. Fewer than 8% of participants in the HIV/STD control group at any assessment reported smoking cigarettes, drinking alcohol, or using dagga in the past 30 days. Thus, the lack of an intervention effect on these behaviors probably was caused by the relatively low usage rates among the participants, making it difficult to achieve even lower rates of use. In a similar vein, the means for drug and alcohol use attitude and intention in the HIV/STD control group were consistently lower than 1.3 on a 5-point scale, making it difficult to instill even more negative attitude and reduced intention in the health-promotion participants. The 2002 South African Youth Risk Behaviour Survey revealed that 21% of learners in grades 8 to 11 reported smoking cigarettes in the past 30 days, 23% reported binge drinking, and 9% reported using dagga (Reddy et al., 2003). Future research with longer-term follow-up will have to examine whether interventions can curb initiation of these behaviors as South African learners reach secondary school.

The content of the health promotion intervention we employed is quite broad, including nutrition, physical activity, and substance use. In addition, the intervention, though 12 hours long, was delivered in 2-hour sessions on six consecutive school days without any booster intervention sessions. Yet, it might be argued that health habits take some time to change. Moreover, changing some of the health behaviors we examined, particularly diet behaviors, but perhaps also physical activity or substance use, may require cooperation from other parties, including parents, who are important for nutrition and providers or co-users who are important for substance use, which would also limit the potential for behavior change. In light of these constraints, the fact that we were able to demonstrate changes in fruit and vegetable consumption and physical activity is impressive. Targeting fewer behaviors and spreading the intervention sessions over a longer period might have resulted in even larger effects on the behaviors targeted. The Cohen's d for meeting 5-a-Day guidelines (0.16) and physical activity (0.27) guidelines were small according to Cohen's rule of thumb (Cohen, 1997), but large compared to effects commonly found in behavior-change intervention trials targeting adolescents in the US (e.g., Johnson, Carey, Marsh, Levin, Scott-Sheldon, 2003). The present results, then, suggest that it is possible to obtain relatively strong effects with the intensive intervention addressing multiple risk behaviors employed in this trial.

This study has a number of methodological strengths. The intervention was developed using both behavior-change theory and extensive formative research. In addition, it was delivered by well-trained co-facilitators who used manualized content, which would enhance fidelity of implementation. Participants were blind to intervention condition prior to enrollment, thus avoiding differential self-selection bias (Pronyk et al., 2006). Matched pairs of schools were randomized to conditions, an attention-control intervention was employed, no schools withdrew from the study, and enrollment rates, intervention attendance, and follow-up retention were excellent, strengthening internal validity. Schools were randomly selected strengthening generalizability to other schools in the area. In addition, we appropriately

adjusted for clustering among participants within schools assessed longitudinally in the analyses.

This study also has limitations. One limitation is the reliance on self-reports of behavior. Another limitation is the lack of physical measures such as body mass index and waist circumference (Taylor et al., 2007) or objective physical activity measures such as accelerometry (Webber et al., 2008). Moreover, the measures of theoretical mediator variables we employed were limited because of our need to avoid undue participant burden in this trial. For instance, we did assess a number of constructs in the theory of planned behavior, including behavioral beliefs, control beliefs, or perceived self-efficacy that might have mediated changes in behavioral outcomes.

In conclusion, several reports call for greater attention to nutrition in addressing HIV/AIDS in developing countries. Interventions for adolescents in sub-Saharan Africa are needed urgently to reduce their health risks. This study provides the first evidence that a cognitive-behavioral, contextually appropriate intervention can increase self-reported health-promotion behaviors, particularly fruit and vegetable consumption, cardiovascular physical activity, and strength-building physical activity, among young South African adolescents. Future research will have to explore whether such interventions can have an impact on more objective outcome variables, including biological and physical measures, and elucidate mediating mechanisms. Additional studies might also determine whether intervention booster sessions and more lengthy programs are more efficacious than the delivery method used in the present trial.

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Table 1

Sociodemographic Characteristics of Participating Schools and Grade 6 Learners by Intervention Condition at Baseline, Mdantsane and Berlin, South Africa 2004–2005.

Characteristic	HIV/STD Intervention	Health-promotion Intervention	Total
School characteristics at baseline			
No.	9	9	18
No. Rural	2	2	4
No. Urban	7	7	14
Mean (SD) No. Classrooms	9.7 (3.2)	8.9 (2.7)	9.3 (2.9)
Mean (SD) No. Classrooms with Electricity	5.6 (5.8)	3.3 (3.8)	4.4 (4.9)
Participant characteristics at baseline			
No.	562	495	1,057
No. (%) Female	306/562 (54.5%)	252/495 (50.9%)	558/1,057 (52.8%)
No. (%) Father present in household	203/544 (37.3%)	194/479 (40.5%)	397/1,023 (38.8%)
No. (%) Rural resident	41/562 (7.3%)	39/495 (7.9%)	80/1,057 (7.6%)
No. (%) Age (years) group			
9–11	144/562 (25.6)%	104/495 (21.0%)	248/1,057 (23.5%)
12–13	330/562 (58.7%)	304/495 (61.4%)	634/1,057 (60.0%)
14–18	88/562 (15.7%)	87/495 (17.6%)	175/1,057 (16.6%)

Table 2

Health Behaviors and Theoretical Mediator Variables by Intervention Condition and Assessment Period, Mdantsane and Berlin, South Africa 2004–2006.

Variable	Baseline	3-Month	6-Month	12-Month
No. (%) 5-a-Day fruit and vegetables in the past 30 days				
Health Intervention	230 (46.46)	299 (60.40)	249 (50.30)	244 (49.29)
HIV/STD Intervention	287 (51.07)	305 (54.27)	259 (46.09)	255 (45.37)
Mean (SE) servings of fruit per day in the past 30 days				
Health Intervention	2.89 (0.15)	4.56 (0.20)	3.75 (0.18)	3.38 (0.18)
HIV/STD Intervention	3.15 (0.15)	3.74 (0.17)	3.11 (0.15)	3.48 (0.18)
Mean (SE) servings of vegetables per day in the past 30 days				
Health Intervention	2.90 (0.16)	4.67 (0.21)	3.85 (0.19)	3.88 (0.20)
HIV/STD Intervention	3.16 (0.15)	3.86 (0.19)	3.05 (0.16)	3.33 (0.18)
No. (%) meeting physical activity guideline in past 7 days				
Health Intervention	214 (43.23)	299 (60.40)	238 (48.08)	249 (50.30)
HIV/STD Intervention	197 (35.05)	224 (39.86)	214 (38.08)	237 (42.17)
Mean (SE) days intensive cardiovascular physical activity in past 7 days				
Health Intervention	4.03 (0.10)	4.75 (0.08)	4.34 (0.08)	4.34 (0.08)
HIV/STD Intervention	4.03 (0.09)	3.96 (0.09)	4.15 (0.08)	3.92 (0.08)
Mean (SE) days moderate cardiovascular physical activity in past 7 days				
Health Intervention	2.66 (0.11)	3.45 (0.11)	3.31 (0.10)	3.43 (0.10)
HIV/STD Intervention	2.53 (0.10)	2.54 (0.10)	2.84 (0.10)	2.73 (0.10)
Mean (SE) days strength-building physical activity in past 7 days				
Health Intervention	2.68 (0.11)	3.34 (0.11)	2.64 (0.11)	2.70 (0.10)
HIV/STD Intervention	2.32 (0.10)	2.50 (0.10)	2.19 (0.09)	2.47 (0.10)
No. (%) smoked cigarettes in past 30 days				
Health Intervention	14 (2.83)	10 (2.02)	6 (1.21)	17 (3.43)
HIV/STD Intervention	17 (3.02)	9 (1.60)	12 (2.14)	14 (2.49)
No. (%) drank alcohol in past 30 days				
Health Intervention	26 (5.25)	30 (6.06)	20 (4.04)	32 (6.46)
HIV/STD Intervention	43 (7.65)	40 (7.12)	26 (4.63)	41 (7.30)
No. (%) binge drinking in past 30 days				

Variable	Baseline	3-Month	6-Month	12-Month
Health Intervention	24 (4.85)	28 (5.66)	19 (3.84)	27 (5.45)
HIV/STD Intervention	31 (5.52)	36 (6.41)	28 (4.98)	39 (6.94)
No. (%) smoked dagga (marijuana) in past 30 days				
Health Intervention	12 (2.42)	4 (0.81)	3 (0.61)	4 (0.81)
HIV/STD Intervention	7 (1.25)	6 (1.07)	6 (1.07)	7 (1.25)
Mean (SE) health knowledge				
Health Intervention	11.21 (0.17)	14.64 (0.13)	14.67 (0.15)	14.69 (0.14)
HIV/STD Intervention	11.14 (0.15)	11.67 (0.17)	12.01 (0.18)	12.50 (0.17)
Mean (SE) attitude toward health-promoting behavior				
Health Intervention	3.54 (0.05)	4.68 (0.03)	4.71 (0.03)	4.68 (0.03)
HIV/STD Intervention	3.65 (0.04)	4.19 (0.04)	4.28 (0.03)	4.34 (0.03)
Mean (SE) intention for health-promoting behavior				
Health Intervention	3.59 (0.05)	4.62 (0.03)	4.65 (0.03)	4.61 (0.03)
HIV/STD Intervention	3.72 (0.04)	4.15 (0.04)	4.22 (0.04)	4.26 (0.04)
Mean (SE) attitude toward using alcohol and drugs				
Health Intervention	1.20 (0.02)	1.18 (0.02)	1.22 (0.02)	1.23 (0.03)
HIV/STD Intervention	1.19 (0.02)	1.21 (0.02)	1.19 (0.02)	1.23 (0.02)
Mean (SE) intention to use alcohol and drugs				
Health Intervention	1.24 (0.02)	1.19 (0.02)	1.20 (0.02)	1.24 (0.03)
HIV/STD Intervention	1.29 (0.02)	1.23 (0.02)	1.26 (0.03)	1.21 (0.02)

Table 3

GEE Empirical Significance Tests and Effect Size Estimates for the Intervention Effect Averaged Over the 3-, 6-, and 12-month Follow-up Assessments Unadjusted for Baseline Prevalence and Adjusted for Baseline Prevalence, Mdantsane and Berlin, South Africa 2004–2006

	Unadjusted for Baseline			Adjusted for Baseline		
Outcome	[a] **Estimate (95% CI)**	**Cohen's *d***	***p* value**	[a] **Estimate (95% CI)**	**Cohen's *d***	***p* value**
Met 5-a-Day guideline in the past 30 days	1.21 (1.00, 1.46)	0.12	0.047	1.30 (1.07, 1.58)	0.16	0.008
Servings of fruit per day in the past 30 days	0.46 (0.07, 0.85)	0.14	0.022	0.54 (0.18, 0.90)	0.19	0.003
Servings of vegetables per day in the past 30 days	0.72 (0.30, 1.14)	0.21	0.0009	0.77 (0.38, 1.16)	0.24	0.0001
Met physical activity guideline in past 7 days	1.71 (1.42, 2.05)	0.33	<0.0001	1.56 (1.29, 1.89)	0.27	<0.0001
Days intensive cardiovascular physical activity in past 7 days	0.47 (0.30, 0.64)	0.34	<0.0001	0.44 (0.27, 0.60)	0.33	<0.0001
Days moderate cardiovascular physical activity in past 7 days	0.69 (0.50, 0.89)	0.44	<0.0001	0.67 (0.47, 0.86)	0.43	<0.0001
Days strength-building physical activity in past 7 days	0.50 (0.29, 0.72)	0.29	<0.0001	0.35 (0.15, 0.56)	0.22	0.0006
Smoked cigarettes in past 30 days	1.07 (0.60, 1.92)	−0.04	0.816	1.06 (0.59, 1.91)	−0.04	0.834
Drank alcohol in past 30 days	0.86 (0.58, 1.26)	0.09	0.434	0.98 (0.67, 1.44)	0.01	0.916
Binged on alcohol in past 30 days	0.80 (0.55, 1.19)	0.14	0.270	0.84 (0.56, 1.24)	0.11	0.369
Health knowledge	2.61 (2.23, 2.99)	0.92	<0.0001	2.54 (2.20, 2.88)	1.03	<0.0001
Attitude toward health-promoting behavior	0.42 (0.34, 0.49)	1.05	<0.0001	0.43 (0.37, 0.51)	0.89	<0.0001
Intention for health-promoting behavior	0.42 (0.34, 0.50)	0.79	<0.0001	0.45 (0.38, 0.53)	0.81	<0.0001
Attitude toward using drugs and alcohol	−0.00 (−0.05, 0.05)	0.00	0.996	−0.00 (−0.05, 0.04)	0.01	0.879
Intention to use drugs and alcohol	−0.02 (−0.07, 0.03)	0.05	0.408	−0.01 (−0.05, 0.04)	0.02	0.794

[a] Estimate = OR (Health intervention versus HIV/STD control) for binary outcome variables meeting 5-a-Day diet and physical activity guideline; estimate = mean difference (Health intervention – HIV/STD control) for continuous outcomes other health behaviors and theoretical mediators. Cohen's *d* is an effect size estimate in standard deviation units calculated using the Cox method for odds ratios and the z test statistic and N from the GEE analysis for continuous variables.