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Original Research Article

The Effectiveness of a Behavioral Modification Intervention to Reduce Cardiovascular Disease Risk Factors amongst Public Secondary School Students in Brong Ahafo Region, Ghana: A Study Design

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ABSTRACT

Aims: Globally, cardiovascular disease (CVD) caused 17.5 million deaths accounting for 46.2% of non-communicable disease deaths. Risk factors among secondary school students in Ghana have reached epidemic levels. Unfortunately, many people have no knowledge of CVD and its risk factors and because of this the disease burden keeps on rising. The aim of this study was to evaluate the effectiveness of a school-based intervention guided by the Information-Motivation-Behavioral skills to reduce CVD risk factors among students.

Methods: A total of 848 students from four secondary schools in Brong Ahafo were randomly assigned to either intervention or control schools (two intervention and two control schools; 212 students per school) of the study. The intervention schools received a CVD risk factor reduction intervention for six months. A Self-administered questionnaire was used for data collection on socio-demographic characteristics, physical activity, smoking, alcohol, dietary habits, CVD knowledge, motivation, and behavioral skills, weight, height, and blood pressure measurements. The intervention included a health education and physical activity modules. A post intervention assessment was carried out at six months to evaluate the effects of the intervention. The generalized linear mixed model was used to test the effectiveness of the intervention between the two groups.

Discussion: Preventive measures must start as soon as possible. This is because school health programs have shown consistent improvement on the health status of students. Since behavioral change remains a driving force for controlling CVDs, there is therefore an urgent need for a behavioral change intervention among secondary school students.

Keywords: Cardiovascular disease risk factors, secondary school students, behavioral modification intervention, IMB model.

BACKGROUND

Cardiovascular disease (CVD) is the leading cause of global deaths. More people die every year from CVDs than any other disease. [1-3] There were 17.5 global deaths in 2012 due to CVDs, which represented 31% of all deaths [4] and affects a third of adult population in the world making it the largest epidemic ever known to mankind. [5] Of these deaths, 6.7 million were caused by stroke and 7.4 million were due to coronary heart disease. The epidemic is not different in Ghana as an estimated 86,200 total deaths occur annually due to NCDs with 55.5% deaths under the age 70 years. Cardiovascular disease is the leading cause

of deaths in Ghana with an estimated 35,000 or 40.6% of NCDs deaths. [6,7] In 2003, CVDs were ranked as the 4th commonest institutional death causing 9% of the total deaths in the country until 2008 when it was ranked as the number cause of death or 14% of total death. [6]

Physical inactivity is showing a rising trend especially among adolescents. Globally, there were 81% adolescents between the ages of 11 to 18 years who were not physically active in 2010. [8] A research was carried out across 34 countries in five WHO regions which included Ghana among 72845 school students with ages between 13 and 15 years to compare physical behavior and sedentary lifestyle. It was found that most of the students were physically inactive and sedentary lifestyle was high. [9] Another study on 400 students between the ages of 6-14 years in Ghana revealed that 32% spent their leisure time playing video games or watching television. [10]

Prevalence of obesity and overweight in children are on the increase and the trends are mostly related to nutritional transition. [11] Worldwide prevalence of overweight and obesity are on the increase among children. For instance in children under five years, there were increase of overweight and obesity from 2000 (5%) to 2010 (6%) and 2013 (6.3%). [8] A research conducted in Ghana of 444 students between the ages of 15-19 years old reported an overweight prevalence of 11.7% and a prevalence rate of 2.9% for obesity. [12] A survey [13] reported that 6.6% and 1.2% secondary school students were found to be overweight and obese respectively and that only 18.7% met the physical activity recommendations on all seven days for at least 60 minutes per day. There is evidence to suggest that lifestyle interventions on modifiable risk factors may prevent the onset of obesity and diabetes. [14]

Tobacco smoking is one of the main causes of preventable deaths. There are about one billion smokers globally. [15] In 2010 in Ghana, tobacco smoke caused 2.7% and 1% male and female deaths respectively. [16] A Global School-based Student Health Survey (GSHS) conducted across 75 Ghanaian secondary schools with a total of 7134 (56.2% males and 43.8% females) students reported that of the number that smoked one or more cigarette in the past 30 days, 45.4% tried their first cigarette smoking at age 13 years or younger. [13] According to the Tobacco Atlas Country Report, [16] 4.3% and 2.9% Ghanaian boys and girls respectively smoked cigarette each day in 2013. A cross sectional survey of students (1805; 49% males, and 51% females) from some selected secondary schools in China revealed that 9% (162) of the students were smokers. However, a large number of the students 81% (1462) had no knowledge related to smoking and tobacco prevention from school. [17]

Globally people (≥15 years of age) consumed 6.2 liters of alcohol in 2010 [8] versus 6.0 liters in the African region. In Ghana, total alcohol consumption per capita in 2010 was 4.8 liters; with males consuming 7.8 liters and 1.9 liters for females. [18] Further, 5.1% DALYs of the global burden of disease is attributed to alcohol consumption. A study conducted among 227 Ghanaians of age 8 years and older reported that 12% of the children take alcohol daily. [19] In a research among 894 secondary school students in Ghana found the prevalence of alcohol usage among students was 25.1%. [20] Yet another survey conducted in Ghana [13] among 7173 students revealed prevalence of alcohol use at 15.3%.

Hypertension is a well-established and a leading risk factor of stroke and coronary heart disease [21] and one of the most important contributors of morbidity and mortality in the world. [22] Controlling the condition reduces morbidity and mortality of CVDs. [23] Prevalence of hypertension across the WHO regions is highest in Africa, at 30% with the lowest prevalence in the region of the Americas at 18%. [8] The research was carried out in

Ghana among 201 youth from three communities between the ages of 12-24 years found that 32.3% and 4% were pre-hypertensive and hypertensive respectively. [24] In 2012 alone, a total of 964,724 newly reported hypertension cases were seen at the outpatient department (OPD) of hospitals across the country. [7] Another study conducted in the United Arab Emirates (UAE) among 999 students below the ages of 18 years had a prevalence of hypertension of 16.6%. [25]

This is an indication that risk factors of CVDs are on the increase among adolescents in Ghana. Some school-based behavioral studies have shown improvements in reducing risk factors of CVDs. A school-based CRCT study showed a 46% reductions of daily smoking among students in the intervention group when compared to the control group [26] and BMI. [27] Other studies showed increases in physical activity levels in the intervention group [28] and fruits and vegetable consumption compared to the control arm. [29]

The Information Motivation Behavioral skills (IMB) model however, postulates a causal relationship among the three factors which includes procedures that can be used to translate the model into health education/promotion interventions. [30] The model explains that complex behaviors require that people are well-informed, well-motivated, and have the necessary objective and perceived skills to engage in the complex behaviors. [31,32] The IMB model assumes that health-related information, motivation, and behavioral skills are necessary to adopt health behaviors. Individuals who are informed, motivated to act, and have the fundamental skills to perform a behavior, are very likely to adopt health behaviors and obtain beneficial health outcomes. On the other hand, individuals who are not informed, are not motivated to act, and do not possess the skills needed to perform a behavior, are very likely to engage in risky behaviors and thus experience unfavorable health outcomes. Information that is directly relevant to the performance of behavior and can reasonably be accomplished within an individual's social ecology is necessary to perform healthy behaviors. Again, with regards to motivation, which is the attitude of an individual towards the health-related behaviors and the support within the environment combines to facilitate the performance of health-related behaviors? In addition to information and motivation, behavioral skills provide the capability for individuals to perform health-related behaviors. This construct of the IMB emphasizes objective abilities and perceived self-efficacy associated with performing the desired behaviors.

The CVD levels among the adult population has become a major public health issue and needs to be controlled immediately by reducing drastically the prevalence of the disease and its risk factors among adults and the youth. Also addressing a single modifiable risk factor still leaves one at a higher risk of developing CVDs because of failure in tackling the other coexistent risk factors. In order to achieve this, preventive measures must start as soon as possible especially among students. This is because school health programs have shown consistent improvement on the general health status of students. We therefore proposed to carry out the effectiveness of a school-based intervention programme on CVD risk factors based on the IMB model in Ghana.

METHODS

Study design

The behavioral CVD risk factor reduction intervention used a single blind parallel cluster randomized controlled trial which involved 848 students from four selected public secondary schools in two districts of the Brong Ahafo region, Ghana. Schools were the unit of randomization, intervention, and analysis. Two schools were randomly allocated to either the intervention group or control group for six months. The study protocol of this trial had

been approved by the ethics committees of the Universiti Putra Malaysia (UPM/TNCPI/RMC/1.4.18.2) and the Kintampo Health Research Centre (KHRCIEC/2017-16). This trial is registered with the Pan African Clinical Trial Registry (PACTR201709002540178). An initial meeting was held with the regional Ministry of Education to ask for their permission to conduct the trial. The research team explained the objectives of the study, duration, and number of students that were to be recruitment into the trial including the inclusion criteria; all public secondary school students from form one to three while students who may be suffering from serious medical conditions such as heart, asthma or respiratory diseases were not included. Two districts were randomly selected with two schools each from each district. The research team then made appointments with the district directors of education in the two selected districts to explain the objectives of the trial and to seek their permission. These were followed with meetings with headmasters/ headmistresses, teachers, and parent teacher association chairmen/chairpersons of the four selected schools to seek their permissions and approval to carry the trial in Fig.1.

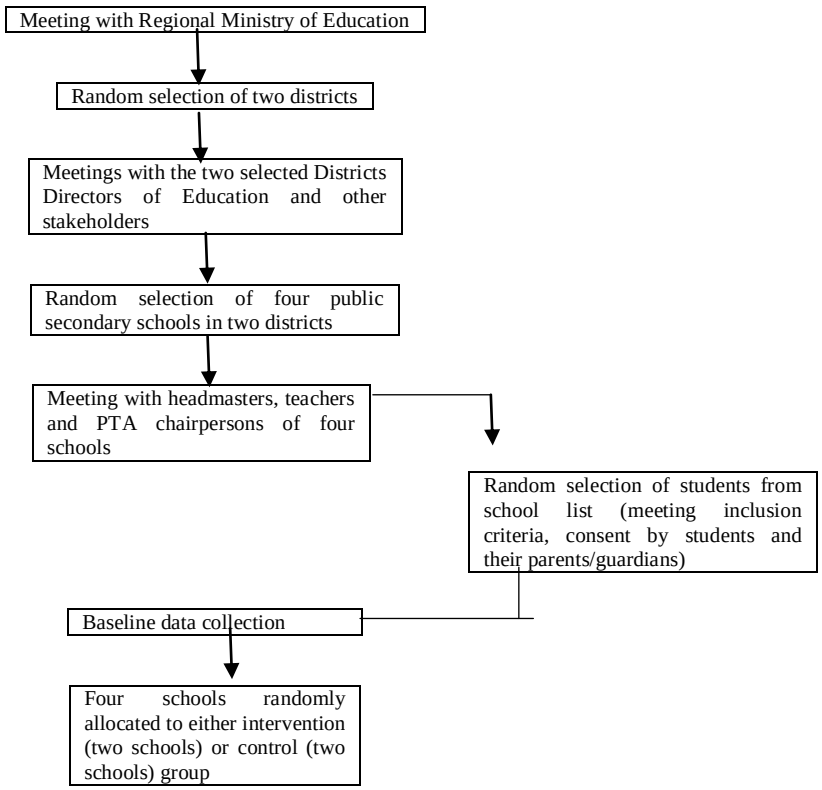

Fig. 1: Flow of school recruitment diagram for CVD risk factor reduction trial

Once schools agreed to participate, a copy of students list were obtained from headmasters and students were selected. The students were then contacted in the schools to explain the objectives of the study to them. They were also informed that participating in the trial was on voluntary basis and that they may decline to participate. Students who agreed to participate went through medical check-up which were carried out by two clinicians in order to pass eligibility criteria. Then they were asked to complete a consent form while they were given another set to pass to their parents/guardians to agree for their wards to participate in the trial. After consent, a baseline data were collected using validated self-administered questionnaire before schools were randomly assigned to either intervention or control groups. There were two schools each in the intervention and the control groups and each school had 212 students in Fig. 2.

Groups	n	Health education & promotion module	Physical activity module	Normal school curricula
Intervention school 1	212	x	x	x
Control school 1	212			x
Intervention school 2	212	x	x	x
Control school 2	212			x
Total	848			
Baseline assessment		Intervention	Post intervention assessment	

Month 0 —— Month 1 ⟶ month 6

Fig 2. Study design

Sample size calculation

The study would require a >80% power to detect an effect of 0.8 standard deviation at the 5% significance level with 0.8 and 0.9 estimated response and eligibility rates respectively. We also expect a 0.01 yielding a cluster design effect of 1.085. The target sample size for each group was calculated to be 424 students or 848 students in total. To achieve this sample size, students from form one to three were recruited from four schools in two districts.

Randomization, Concealment, Implementation and Blinding

Randomization technique in the ratio 1:1 for intervention and control groups respectively was carried out. Randomization of schools to intervention or control was done after baseline data were collected. Using a block randomization (1:1 ratio) of two digit blocks (A and B), to ensure equal distributions in the two groups, two schools each were allocated to intervention and control groups. Randomization was carried out by an independent biostatistician who was not involved in the trial generated the allocation sequence. Allocation concealment was achieved with sequentially numbered opaque sealed envelopes based on alphabetical order of the schools containing treatment allocation cards (intervention and control). Then a representative from each of the four schools was asked to pick an envelope of their school. An education officer who knew nothing about the research and not affiliated to any of the schools was responsible for opening the envelopes in sequence and assigned schools to study groups. Health staff who took anthropometry and blood pressure measurements at baseline did not take part in the post intervention measurements to avoid measurements bias.

Intervention

The behavioral modification intervention to reduce cardiovascular disease risk factors amongst public secondary school students was developed on the premise of the IMB model to effect behavior change to reduce CVD risk factors among secondary school students. The IMB is based on a critical review and integration of constructs of behavioral theories, which contain key factors that are needed for modification of a wide range of health-related behaviors. Table 1 shows how the IMB model was addressed by the intervention.

The main components of this intervention study and activities performed are summarized in table 2. The CVD risk factor reduction intervention module was divided mainly into two sections guided by the IMB model. These were the Health Education and Promotion and the Physical Activity Modules. The interactive health education and promotion sections, the researchers did education on CVDs, its risk factors, causes, development and prevention among others in the intervention schools three times a week for a period of six months. Each section lasted for about an hour with a ten minutes break. The physical activity module consisted of hands on exercises and was delivered by a physical education health instructor. Students were educated first on the various physical activities and they were taken to the school

field to undertake these activities. The exercises were structured across the intervention schools. Each physical activity section lasted between 25 to 30 minutes with short breaks. Students, at the end of this trial, are expected not only to protect themselves from CVD risk factors, but to act as change agents among their peers and in the home.

Table 1: Application of the Information-Motivation-Behavioral Skills for school base CVD risk factor reduction intervention

IMB model	Secondary school CVD risk factor reduction module
Information	Knowledge of cardiovascular disease and its risk factors: -Students were informed how modifiable risk factors translated into intermediary risk factors and into CVDs. Prevention of CVDs through modifiable risk factors: -Students were taught on reduction of modifiable risk factors of CVDs. These included: -Physical Activity: Doing at least 60 minutes moderate to vigorous physical activity daily. -Diet: Consumption of healthy diet devoid of too much salt, too much sugar, too much fat, too much fried foods, and red meat. -Consumption of fruits and vegetables, drinking enough plain water instead of coloured (sugar) water, fish, whole grains instead of polished grains. -Smoking: Information on tobacco, stopping smoking (for student smokers) and not initiating smoking for non-smokers. -Alcohol: Same with alcohol consumption as with smoking.
Motivation	Students were encouraged that if they performed the required physical activity on daily basis and eat healthy foods they would become smart and would be free from obesity, diabetes, and being hypertensive. They would also be free from other diseases. -They were further encouraged and taught that not initiating/stopping smoking and alcohol would make their lungs and heart function properly, strong, and free from heart diseases. -Peer groups to educate fellow students to serve as a source of motivation. -Poster, Sport and dancing competitions, group work and interactions, and role plays to motivate students.
Behavioral skills	Students were taught to demonstrate the ability to select their foods, to choose drinks with reduced sugar content, to reduce salt intake, to choose the appropriate fruits and vegetables, to know the skill to perform the various forms of physical activities, stop/not initiate smoking and alcohol consumption.

Table 2: Summary of intervention module components

MODULE	COMPONENTS	FORM OF DELIVERY
Health education and promotion module	• Module introduction • CVD introduction • CVD risk factor introduction • Harmful effects of smoking • Quitting smoking • Barriers to quitting smoking • Health benefits of quitting/not initiating smoking • Physical activity introduction • Simple physical activities/exercises • Fruits and vegetables introduction • Fruits and vegetables intake/selection • Introduction to the types of fats • Outcomes of high fat intake on health • Harmful effects of obesity • Harmful effects of excessive sugar intake • Promotion of frequent water intake • Harmful effects of excessive salt intake • Harmful effects of alcohol • Quitting alcohol • Barriers to quitting alcohol • health benefits of quitting/not initiating alcohol	Short Lectures Discussions
Physical activity module	• Aerobics • Lunge with twist • Jumping jacks • Abdominal crunch • Hamstring stretch • Wall sit • Side arm and leg raise • Push ups • Sit and reach • Sit ups • Knee to chest • Leg raise • Squat	Hands on/field exercise

Outcome Measures

Primary Outcomes

Physical Activity

Physical activity was measured using the physical activity questionnaire for secondary school students. [33] It is a 7-day recall instrument to assess levels of physical activity of children and adolescents.

Smoking and Alcohol

Smoking and alcohol consumption questionnaires, Global Youth Tobacco Survey (GYTS) developed by WHO and Centre for Disease Control and prevention, CDC [34] was used to assess smoking and alcohol statuses. Students were assessed as ever, current, and never smoker and alcohol use. Strict confidentiality was ensured among researchers to avoid disclosure of smoking and alcohol statuses to teachers, school authorities or parents.

Dietary Habits

This was a 7-day dietary recall instrument which are foods items mostly consumed in Ghana [35,36] to assess dietary consumption. The study analyzed frequency of consumption of fruits, vegetables, seafood, non-seafood, sweet snacks, carbonated drinks, salted fish and fried foods.

Knowledge, Motivation, and Behavioral Skills

Cardiovascular disease knowledge and its risk factors consisted of 26 modified questionnaire developed by George et al. [37] to assess students' knowledge of CVDs and its risk factors. The maximum score is 26 and the minimum score is 0. Motivation and behavioral skills were the modified versions of the Life Windows Information-Motivation-Behavioral skills ART adherence questionnaires [38] which constructs were originally developed by J.D Fisher et al. [39] These consists of 10 questions each.

Secondary Outcomes

Anthropometric Measurements

Anthropometric measurements were weight and height. Weight was measured with TANITA Model HD 309 and height with SECA Body Meter Model 208. [40,41] Each respondent was asked to remove shoe and any material in the pocket. The student is asked to stand straight on the scale and measurement taken. For height, respondent was asked to stand and look straight, barefooted with heels resting together. Height measurement which appeared in the read-off area was recorded. The BMI was used to classify students as proxy to their nutritional status in terms of underweight, normal weight, overweight, and obesity which is based on the CDC age for percentile chart. [42]

Blood Pressure Measurements

Blood pressure measurements were taken with Omron automated BP monitor which was measured by qualified health staff. Two blood pressure measurements were taken for each student and the average of the two was used to classify students. A minute's rest interval was allowed after the first reading before the second measurement was taken. [43] Classification was based on WHO [44] guidelines for children and adolescents.

Data Analysis

Data collected was analyzed using IBM Statistical Package for Social Sciences (SPSS) version 22. Significance level for statistical tests was set at 0.05 and mean estimations at 95% confidence intervals (CI). Chi-square tests were performed to compare baseline characteristics of the intervention and control groups by their socio-demographic factors. The t-test was used to compare CVD risk factors at baseline. At six months, a mixed design repeated measures Anova test was carried out to determine the between and within group differences and its interactions on time differences of risk factors of CVDs while the McNemar test was used for

categorical variables. Intention-to-treat (ITT) analysis was the strategy used to handle missing data. Multiple imputation method analysis was then used to handle missing data. After we replaced missing data, then we performed a Generalized Linear Mixed Model (GLMM) to determine the overall effectiveness of the intervention in table 3.

Table 3: Analysis plan of study

No.	Test	Test type	*p* value
1.	Comparison of socio-demographic characteristics between intervention and control groups at baseline.	Chi-square test	$p<0.05$
2.	Comparison of knowledge, motivation, behavioral skills and CVD risk factors (physical inactivity, smoking, alcohol consumption, unhealthy diet, BMI, diastolic and systolic blood pressures) between the two groups at baseline.	a. Independent t-test (continuous variables) b. Chi-square test (categorical variables)	$p<0.05$ $p<0.05$
3.	Evaluating the effectiveness of intervention program to increase knowledge, motivation, behavioral skills and to reduce CVD risk factors between intervention group as compared to control groups at six months post intervention and also within groups from baseline to six months.	a. Mixed design repeated measures Anova b. McNemar tests (categorical variables) c. Generalized Linear Mixed Model (GLMM)	$p<0.05$ $p<0.05$ $p<0.05$

DISCUSSION

Cardiovascular diseases are currently the most leading causes of deaths worldwide with risk factors including hyperlipidemia, smoking, diabetes, and gender among others [45] and has become epidemic in both developing and developed nations. [46] Sub-Saharan Africa was the only WHO region where CVD-related deaths increased between 1990 and 2013 [47] and has since become the leading cause of CVD morbidity and mortality. [48]

Cardiovascular disease affects people between the ages of 30-70 years but the risk factors begin in childhood and carried through adulthood. [49] The adolescents phase presents opportunities for health and this pattern determines the future (adulthood) health status of the individual. [50] Schools therefore can play a major role in improving the health status of students and adolescents and the adults they will become. Students are in school throughout the academic year and spend generally five days a week in school. This is because at this crucial adolescent age, students learn certain habits that influence behaviors such as tobacco smoking, eating habits, physical activities (and alcohol use) that could lead to chronic diseases like cardiovascular diseases, cancers and diabetes which are now the leading causes of global death. [51]

Domitrovich et al. [52] reported in their study that school-based behavior and social learning interventions have positive impacts on students' outcomes such as substance use. The WHO [53] has indicated that school health interventions have the benefit of improving health and preventing health related risk among the youth. Chen et al. [54] indicated that school-based intervention studies provide access to a large number of school children, who are often from different socioeconomic backgrounds and serves as opportunities to establish programs in communities. School-based non-communicable disease (NCD) prevention interventions are important since they are key settings to improve health. [55] Studies have also shown that school-based interventions are effective on CVDs especially in decreasing the consumption of unhealthy diets, improving physical activity and preventing obesity. Again, it has been reported that students could impact CVD knowledge to their parents and the whole family. [56]

Again, CVDs can be prevented if cost-effective interventions that reduce the risk factors of the diseases are made available to people [57] and that addressing a single modifiable risk factor still leaves one at a higher risk of developing CVDs because of failure in tackling the other

coexistent risk factors. Also merely educating students on healthy lifestyles without interventions by reducing CVD risk factors may not be enough. Therefore to reduce this health and economic burdens of the disease, the prevalence of the disease and its risk factors among the youth and adults must be reduced drastically. In order to achieve this, preventive measures must start as soon as possible among students in schools. This is because school health programs have shown consistent improvement on the general health status of students. Since behavioral change still remains a driving force for curbing CVDs, there is therefore an urgent need for a behavioral change prevention intervention among secondary school students. We then proposed an intervention aimed at adolescents in schools. We believe that a behavioral change could have a positive effect in reducing CVD risk factors among the youth. The findings from this study would contribute to the body of knowledge on CVD risk factors among the secondary school students. The study also has the potential to influence health and education policy in Ghana and further afield.

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Authors' contributions: JA conceived the study. JA, SMS, and LR designed the study. JA drafted the manuscript with supports from RAM, NI, SMS and LR. JA and SMS designed the statistical analysis. All authors reviewed and approved the final manuscript.

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