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Effectiveness of modified health belief model-based intervention to reduce body mass index for age in overweight junior high school students in Thailand

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Abstract

Purpose – The purpose of this paper is to determine the effectiveness of a modified HBM-based intervention to reduce body mass index (BMI) for age in overweight junior high school students.

Design/methodology/approach – A cluster-randomized controlled trial was conducted in the first and second years of a junior high school in the center of Thailand. In total, 24 classrooms were randomly assigned to a modified health belief model intervention arm (HBMIA), and 24 classrooms were randomly assigned to a traditional school health education arm (control). In total, 479 students who were overweight (BMI forage = median +1 SD, aged 12–15 years) participated in the study. The HBMIA used the health belief model (HBM) as a motivator for behavioral strategies that included modifying diet and participating in physical activity. BMI, health knowledge and behavior for preventing obesity were recorded at baseline and at six months. A multilevel regression model was performed to calculate mean difference between HBMIA and control group.

Findings – The students who participated in the HBMIA showed a decrease in BMI of 1.76 kg/m^2, while those who participated in the control showed an increase in BMI of 1.13 kg/m^2, with a mean difference of –2.88 kg/m^2 (95% CI = –3.01 to –2.75), an improvement in health knowledge (mean difference 27.28; 95% CI = 26.15–28.41) and an improvement in health behavior (mean difference 23.54; 95% CI = 22.60–24.48).

Originality/value – A modified HBM-based intervention to reduce BMI for age is effective in overweight junior high school students.

Keywords Overweight, Body mass index, Health belief model

Paper type Research paper

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Introduction

Obesity is a major global problem many countries face. Overweight and obesity are important risk factors for mortality and chronic disease[1]. Overweight and obesity also result in lower intelligence, slow learning, low immunity and increased risk of infection[2]. There has been a rapid increase in the prevalence of overweight adolescents in recent years. Overweight is now one of the most common adolescent health problems, and has significant adverse effects on physical and psychosocial health in adolescence and adulthood[3].

In Thailand early adolescence, the age between childhood and adolescence is a period of education at junior high school level. One of the most noticeable changes during this period is the rapid growth of almost every part of the body (the growth spurt) that takes place in the transition from childhood to adulthood. When the growth spurt starts, children tend to eat more, and their body accordingly increases accordingly. Weight gain depends on genetic factors, food consumption, exercise and gender[4]. If eating habits are not controlled by exercise, people will become overweight. Dietary control, an increase in body movement and exercise, and behavioral modification using parents as the role models of good health habits are effective treatment strategies for long-term weight control among juveniles[5, 6]. In addition, studies on weight control by implementing the body mass index (BMI) change program, using exercise along with dietary control, show that it can effectively reduce obesity. Based on studies abroad and in Thailand, weight control programs are effective, and participants can lose weight but not ensure behavioral changes over the long term[5, 6].

Previous studies have reported that the treatment of overweight adolescents has flaws in the methodology used, such as small sample sizes, high dropout rates, short-term follow-up, lack of detail about the randomization process, lack of blinding and failure to use intention-to-treat analysis[3, 7–9]. Intensive behavioral programs aimed at engineering change among overweight children have proved successful in clinical studies from one center in the USA[3, 7, 8]; however, because such interventions have been intense, they may not be readily generalizable to all health-care systems. Previous studies, therefore, have concluded that there is an urgent need for high-quality studies that test more generalizable intervention treatments among overweight adolescents[3, 7–9]. Nevertheless, previous studies have found that for a long-term weight control program to be effective, the parents should play a role in stimulating behavioral changes. Parents serve as a good role model and provide support to overweight adolescents[5, 6]. The recent studies presented above are consistent with concepts and theories that are useful as a basis for BMI-for-age changing programs for overweight junior high school students. They are also consistent with the health belief model (HBM), which provides motivation to change health behaviors.

Recent studies have found that HBM is useful in addressing many health problems. Among these are that it can improve the poor eating habits of pregnant women[10], prevent osteoporosis[11], prevent accidents among children younger than five years old[12] and increase patient compliance[13]. Recent studies have shown that health problems can be successfully solved by HBM because of the basic components of perception and motivation. If people are to avoid disease, they must believe there is a risk that the disease will severely affect their lifestyle; they must also believe that applying HBM may reduce the risk of disease or its severity[14, 15]. Overweight junior high school students are at higher risk of developing many health issues than their peers. These issues include non-communicable diseases, breathing problems, musculoskeletal discomfort and psychological problems. Among overweight junior high school students, 30 percent become obese adults[16]. Therefore, the aim of this cluster RCT was to examine the effectiveness of the modified HBM-based intervention for reducing BMI for age in overweight junior high school students, aged between 12 and 15 years. We also measured health knowledge and health behavior. The design, conduct and reporting of the trial followed the guidelines of Consolidated Standards of Reporting Trials (CONSORT)[17].

Materials

Human subjects approval statement

The research described in this study was conducted with the approval of the Human Research Protection Unit, Faculty of Medicine, Chulalongkorn University, IRB No. 551/59, in a meeting held on November 17, 2016. Participants received information about the research and were given the opportunity to ask questions before participating. The study has also been registered at clinicaltrials.gov under Trial No. NCT02904486.

Participants

This cluster-randomized controlled trial was conducted at the schools under Thailand's Ministry of Education. The allocation of study conditions followed a two-step procedure. First, two schools were randomly selected from a list of all eligible schools. Second, 24 classrooms were randomly assigned to a modified health belief model intervention arm (HBMIA) and 24 classrooms were randomly assigned to a traditional school health education arm (control). Eligibility criteria for participants were students who were overweight (BMI-for-age $\geqslant$ median +1 SD)[18] and were attending junior high school (first and second years) (aged 12–15 years). We excluded children who had an underlying medical cause of their excess weight or who had serious comorbidity that required urgent treatment, or who had received treatment for being overweight. Overweight students were recruited by researchers and school nurses. Written informed consent was obtained from all students and their parents/guardians.

Sample size calculations were performed to determine the number of students needed to detect 1.0 kg/m^2 difference between the HBMIA and control group. A sample of 205 per group was required to achieve 80 percent power with a two-tailed significance of 0.05, assuming an equal variance of 10.89 in both groups. Estimating a 10 percent dropout during the study, a minimum of 227 students per group was needed to reach the target of 205 students per group, as show in Figure 1.

Randomization and concealment

The overweight students attended a baseline assessment where the researcher obtained consent, recorded baseline measurements and assigned a study code. To ensure concealment, we produced a computer-generated randomization list and allocated the participants' group classroom to the intervention or control group. Participants commenced intervention or control treatments within one week of the baseline measurements.

Intervention

HBM intervention arm. The program consisted of five main activities applied from the HBM and 11 appointments (nine student visits, one school director visit and one home visit) over a six-month period, with each contact session lasting 50 min. We used various behavioral change techniques to enhance the students' motivation to make lifestyle changes. They were: first, "Perceived susceptibility of obesity"; students who were perceived susceptible to obesity were educated on "Obesity and Causes in Children" (using cartoon animation), and behavioral factors relating to their overweight were reviewed. Second, "Perceived severity of obesity" referred to the beliefs a person holds concerning the effects of obesity; this technique informed the children about these effects and educated them on the "Adverse Effect and Severity of Obesity in Children," which enumerated the consequences of obesity in children in all aspects, such as health, family life and social life. In this regard, the researchers focused on using appropriate content for the child's developmental age (using cartoon animation). Third, "Perceived benefit for the prevention of obesity"; students received books on health education and health behavior

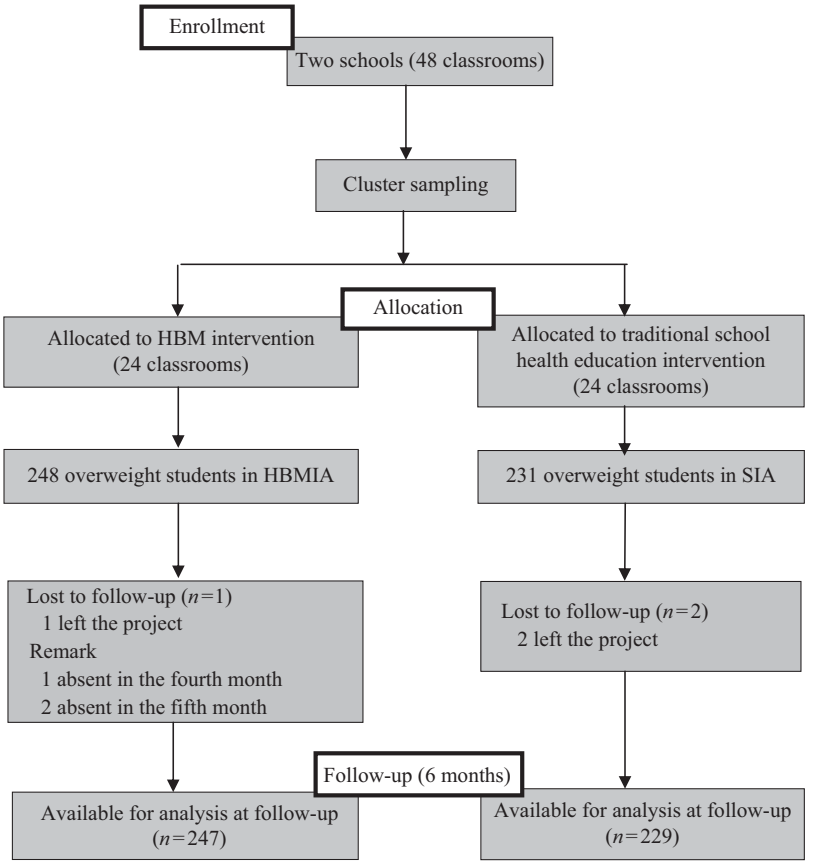

Figure 1.
Participant flow chart

that showed them how to prevent obesity. Fourth, "Perceived barriers for the prevention of obesity"; students exchanged their experiences of the disadvantages or barriers they had to overcome in trying to change their behaviors. School management and teachers were invited to participate in arranging a proper environment for the practice. Finally, "Cues to action for the prevention of obesity"; we used a family-centered approach by visiting students' homes to stimulate awareness and change behavior based on family support. Behavior should be changed for a period of at least six months to be effective[19-21]. Hence, this intervention was evaluated in the sixth month.

Students were encouraged to change their diet by reducing their intake of fatty foods and sugar, increase their intake of fruit and vegetables, increase their physical activity and restrict their sedentary behavior. Watching television and playing computer/video games were limited to no more than 2 h per day or the equivalent of 14 h per week, a period family members widely recommended and supported to help change their children's behavior.

Traditional school health education arm (control). Students who were randomly assigned to the control group received a traditional school health education from the research team who, with teachers of general health education, collaborated to provide a standard intervention in the control group on the same day as the participants in the HBMIA.

Outcomes and blinding

The researcher recorded the outcome measures at baseline and then at six months after the start of the program. The participants were blinded to group allocation throughout the trial. Measures were put in place to ensure blinding, and the researcher had to report incidents of possible unblinding.

Our primary outcome was BMI. The researcher measured the weight, height and waist circumference of the students, who wore light indoor clothing and no socks and shoes. BMI for age was assessed in the range $\geqslant$ median $-$ 1 SD and $<$ median + 1 SD, which were recorded as normal, $\geqslant$ median +1 SD and $<$ median + 2 SD, which were defined as the beginning of obesity or overweight, $\geqslant$ median + 2 SD and $<$ median + 3 SD, which were designated obesity and BMI $\geqslant$ median + 3 SD, which was designated severe obesity[22].

We measured health knowledge and obesity prevention using a standardized questionnaire comprising six parts (35 questions) developed by the Health Education Division, Department of Health Service Support, Ministry of Public Health, Thailand (2016) which Cronbach's α was 0.75[23].

Health behavior was measured using standardized questionnaires developed by the Health Education Division, Department of Health Service Support, Ministry of Public Health, Thailand (2016)[23]. We assessed the obesity prevention health behavior of participating students using a questionnaire with 20 questions to be scored on a five-level Likert scale. An assessment of a reliability test revealed a Cronbach's α coefficient of 0.82.

Statistical analysis

Statistical analysis was performed on an intention-to-treat basis for each outcome measure, and involved all participants who attended for follow-up measures, regardless of whether they completed the treatment using data at baseline instead of value outcome at six months after the start of the program. Descriptive statistics were performed to determine the sociodemographic characteristics and physical examination of the study participants. Numbers and percentages are reported for categorical variables and means with standard deviations and ranges for continuous variables.

We calculated changes in BMI, health knowledge score and health behavior determinants from baseline to six-month follow up in HBMIA and control group. To compare the changed scores between the intervention group and the control group, we performed conditional multilevel regression model procedures after adjusting for baseline unbalanced variables (i.e. gender, GPA and parents' education level), with schools and classroom included as random effects. We also performed a planned per-protocol analysis for outcome using only intervention and control participants who complied well and were involved in all the program's sessions. All statistical analyses were conducted with STATA software version 15.0 (Stata Corp. 2017. Stata Statistical Software: Release 15. College Station, TX: Stata Corp LLC), and the level of significance was set at 0.05.

Results

In total, 479 overweight eligible students from 48 classrooms agreed to participate in the study. Out of those, 248 overweight students from 24 classrooms were randomly assigned to the HBMIA (intervention group) while 231 overweight students from other 24 classrooms were assigned to the SIA (control group). Of the 248 students who were randomly assigned to the intervention group, 247 (99.6 percent) completed the six-month follow-up. Of the 231 students who were randomly assigned to the control group, 229 (99.1 percent) completed the six-month follow-up (Figure 1). The sociodemographic characteristics and physical examination of the HBMIA and SIA participants were presented in Table I. Compared with the term group, the individuals assigned to HBMIA and SIA groups were similar in age, and they all lived close to a convenience store. The demographic analysis was conducted to

Characteristics	*n* (%) HBMIA (*n* = 248)	Control (*n* = 231)
Gender		
Male	109 (44.0)	127 (55.0)
Female	139 (56.0)	104 (45.0)
Age (years)		
Mean ± SD	13.70±0.74	13.76±0.76
Minimum – Maximum	11.83 – 15.75	12.00 – 15.50
GPA		
Mean ± SD	2.77±0.63	2.62±0.59
Minimum – Maximum	1.11 – 3.98	1.04 – 3.89
House closed to a convenience store		
Yes	161 (64.9)	161 (69.7)
No	87 (35.1)	70 (30.3)
Parent's education level		
Under junior high school	32 (12.9)	51 (22.1)
Junior high school	34 (13.7)	40 (17.3)
Senior high school	83 (33.5)	81 (35.1)
Diploma	24 (9.7)	17 (7.4)
Bachelor's degree and postgraduate	75 (30.2)	42 (18.1)
Family's economic status		
Sufficient with moderate amount of savings	196 (79.0)	181 (78.4)
Sufficient with almost no savings	36 (14.5)	35 (15.2)
Not sufficient with some debts	14 (5.7)	13 (5.5)
Not sufficient with high amount of debts	2 (0.8)	2 (0.9)
Body mass index (kg/m^2)		
Mean ± SD	27.16±4.33	27.53±4.42
Minimum – Maximum	20.81 – 44.73	21.30 – 48.36
Z-score of BMI for age (kg/m^2)		
⩾ Median + 1 SD and < median + 2 SD (overweight)	109 (44.0)	96 (41.6)
⩾ Median + 2 SD and < median + 3 SD (Obesity)	110 (44.3)	106 (45.9)
⩾ Median + 3 SD (severe obesity)	29 (11.7)	29 (12.5)

Table I. Baseline characteristics of participants

determine the family's economic status, the participants' BMI and the *Z*-scores for BMI for age. The two groups differed in the sociodemographic characteristics (i.e. in terms of gender, GPA and parents' education level).

In the primary intention-to-treat analysis, significant differences were observed between the HBMIA and control groups in terms of BMI, health knowledge score and health behavior score from baseline to six months. These differences are presented in Table II. The BMI score among the HBMIA group decreased (−1.76 kg/m^2), while the control group showed a BMI increase (1.13 kg/m^2), with an unadjusted mean difference of –2.89 mg/m^2 (95% CI = –3.01 to –2.76) and an adjusted mean difference of –2.88 mg/m^2 (95% CI = –3.01 to –2.75). Regarding the change in health knowledge and health behavior, health knowledge increased among the HBMIA participants (25.12) but decreased among the control group (−1.59), with an unadjusted mean difference of 26.71 (95% CI = 25.59–27.82) and an adjusted mean difference of 27.28 (95% CI = 26.15–28.41). Health behavior scores increased in the HBMIA group (21.18), while those in the control group decreased (−2.10), with an unadjusted mean difference of 23.28 (95% CI = 22.37–24.19) and an adjusted mean difference of 23.54 (95% CI = 22.60–24.48) (Table II).

Main variables	HBMIA ($n = 248$) Mean ± SD	Control ($n = 231$) Mean ± SD	Unadjusted mean differences[d] (95% CI)	Adjusted mean differences[a,d] (95% CI)
Body mass index (kg/m^2)				
Baseline	27.16±4.33	27.53±4.42		
6 months	25.40±4.35	28.66±4.38		
Change[c]	−1.76±0.76	1.13±0.62	−2.89 (−3.01, −2.76)	−2.88 (−3.01, −2.75)
Health knowledge score[b] *(score)*				
Baseline	86.05±12.86	83.58±12.06		
6 months	111.17±6.18	81.99±11.54		
Change[c]	25.12±8.17	−1.59±2.98	26.71 (25.59, 27.82)	27.28 (26.15, 28.41)
Health behavior (score)				
Baseline	63.88±7.89	63.30±8.27		
6 months	85.06±3.96	61.20±7.39		
Change[c]	21.18±6.25	−2.10±3.39	23.28 (22.37, 24.19)	23.54 (22.60, 24.48)

Table II. Comparison of effectiveness among participants who received HBMIA and those who received control

Notes: Data were analyzed as intention to treat. [a]Adjusted by gender, academic achievement (GPA) and parents' education level; [b]including health knowledge of obesity prevention, access to information and health services, communication to increase expertise, managing self-health conditions, understanding the media and information, and making the right decision; [c]change = 6 months – baseline; [d]mean differences = HBMIA – control

We also performed a per-protocol analysis for score changes in BMI, health knowledge and health behavior using only intervention and control participants who complied with all sessions in the program and fully committed to it; 247 participants were included in the analysis on HBMIA at six months, and 229 participants were included in the analysis on control group at six months. The results were more likely to be intention-to-treat analysis.

Discussion

We are among the first study in Thailand to examine a best-practices program and home visit based on a modified HBM applied to prevent and reduce overweight among junior high school students. The intervention program based on the generalizable modified HBM tested in this study showed significant benefits in terms of BMI reduction and increased health knowledge and health behavior. Furthermore, for participants who complied well with the program, the outcomes were significantly higher in the HBMIA group compared with the control subjects from baseline to six months. However, at six months, we observed no improvement in BMI, health knowledge and health behavior among overweight students receiving standard care (control group). The significant benefits observed in reduced BMI and increased health knowledge and health behavior in the HBMIA group may reflect differences in treatment targets: our HBMIA focused on diet, physical activity and reducing sedentary behavior to achieve change via the HBM, whereas standard care had minimal emphasis on motivating behavioral change through diet and physical activity. Furthermore, standard care did not target sedentary behavior. This study, therefore, provides some evidence that the inclusion of these behavioral change targets as part of treatment is worthwhile, even though the changes in activity behavior were moderate. There is widespread concern, particularly from parents, that treating overweight students may increase the risk of adverse effects; however, research in this area is limited[3, 24]. We found that our modified HBM-based intervention program, which included the support of family, the schools, teachers and society, did not adversely affect the students' growth or quality of life.

We found that the modified HBM-based intervention program was successful in contrast with the no-treatment control group. Previous studies in Scotland and Denmark have shown that BMI *z*-scores decreased significantly among overweight children who received treatment over 12 months[3, 25]. In contrast, this study found significant decreases in BMI at six months in the HBMIA group[19–21]; furthermore, the clinical significance of these changes is clear because evidence from the modified HBM-based intervention program suggests that students' beliefs about health problems and the perceived benefits and barriers to changing their behavior and self-efficacy explain their engagement (or lack of engagement) in health-promoting behavior, because they serve as a stimulus for the students to change their behavior and maintain health-promoting behavior[26]. The results of the BMI measurements at six months clearly show that the students consequently had increased knowledge and achieved behavioral changes to help them prevent obesity. It is possible that the students' motivation to change their behavior involved stakeholder support in solving problems; therefore, family, the schools, teachers and society in this study were more resistant to the program[5, 6, 27, 28]. We also provided cooperation and support to the participants during the whole period of six months.

In addition, treatment programs that use an HBM to change students' lifestyle are more likely to be successful in the treatment of overweight children[29–31]; therefore, we used this HBM to develop a generalizable, HBM-based intervention delivered by a researcher and school nurses in a school setting, thereby making the manpower burden and treatment costs generalizable. We also ensured that the HBM modified in the intervention was of a very high quality. The intervention group researcher team was highly trained in counseling children on behavioral change[32].

Interestingly, the results of the present study show that most of the students in both groups lived close to a convenience store, and the family's economic status was sufficient. It can be seen that in both groups the factors affecting obesity were similar. Thus, it was possible that the causes of obesity in this study are related to the students' social and environmental factors. Previous studies have reported that society and the environment promote overweight and obesity. Also, the chances of finding obese children are higher in urban societies than in rural societies. In urban societies, there is more competition; therefore, children's behavior in their leisure time changes. Children need to take extra lessons, which negatively influence their exercise time. As a result, the balance between energy consumption and total consumption becomes disrupted, leading to what is called an obesogenic environment[33, 34], which includes parental education and family economic status[35]. In higher-income families, obesity rates are higher[36].

This study has several strengths, including the relatively large sample of the intervention and the control group and the fact that we used only a well-trained, calibrated and blinded school nurse to examine all participants. The high retention rates for the intervention and control group (99.6 and 99.1 percent) also served to attenuate concerns about compliance using intention-to-treat analysis and properly conducted randomization procedures. However, several limitations should be acknowledged when interpreting the results of our study. First, this study was an intervention program that was relatively intensive and short compared to other studies, which were of longer duration. Therefore, it was possible that the participants were biased and the measures outcome errors. It is possible that a more intense intervention of longer duration than the one used in this study may have been more successful, but our aim was to test an intervention that was practical and thus likely to be generally applicable. Alternatively, the family support applied at home during the intervention may have allowed families to set lifestyle goals that affected health knowledge and health behavior.

Conclusions

The HBM modified for intervention had the benefit of reducing the BMI for age among overweight junior high school students who complied with the program. It also improved the participants' knowledge about health and their health behavior. Although such a program may not be realistic for many health-care systems, our findings may be useful in the development of future treatment programs. More research may be needed to provide various activities for inclusion in the HBM intervention program. It could also be useful to apply the model to different targets, such as overweight primary school students, obese diabetic patients, etc.

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