

Development of a health promotion model for modifying mobile applications among overweight working people in PHRA Nakhon Si Ayutthaya province

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Abstract: This research and development study aimed to develop and evaluate the effectiveness of a health promotion model for overweight working-age individuals using a mobile application. Phase 1: The preliminary design of the health promotion model was conducted among 110 overweight industrial workers, focusing on dietary and physical activity interventions. Phase 2: The model was further developed and refined through testing with a small sample group of 10 individuals, resulting in a prototype of the health promotion model utilizing the mobile application. Phase 3: The effectiveness of the health promotion model was evaluated through an experimental study involving 45 participants in both the experimental and control groups. Data were analyzed using t-tests. Research Findings, after participating in the program, the experimental group showed statistically significant improvements in dietary behaviors, physical activity, body weight, muscle mass, and fat mass compared to pre-intervention measurements. However, there were no significant changes in their perceived risks or severity of overweight conditions. No significant differences were observed in health behaviors or health status between the experimental and control groups before and after the intervention.

Keywords: Health promotion, Mobile application, Overweight, Working adults.

1. Introduction

Overweight has increased approximately threefold over the past 40 years. In 2016, 39% of the global population aged 18 and older was overweight (1.9 billion people), and 13% (650 million people) were obese. This trend continues to rise without any indication of decline. By 2030, it is projected that 2.16 billion people will be overweight, and 1.12 billion will be obese. In Thailand, the prevalence of overweight (BMI ≥ 25 kg/m²) among the population aged 15 and older has increased from 34.7% in 2008-2009 to 42.2% in 2014-2015 (Division of Noncommunicable Diseases, Department of Disease Control, Ministry of Public Health, 2019). This increase is linked to the rising rates of hypertension and diabetes. Hypertension prevalence rose from 21.4% in 2008-2009 to 25.4% in 2014-2015, while diabetes prevalence increased from 6.9% to 9.5% in the same periods. Health surveys show a clear upward trend in overweight prevalence in both male and female populations. Although the prevalence in men is lower than in women, the increase rate in men is faster. The 5th survey in 2014 and the 6th survey in 2019-2020 indicated that the prevalence of overweight in women increased from 41.8% to 46.4%, while in men it rose from 32.9% to 37.8%. Reports from the Health Data Center, Ministry of Public Health, (2022) show a decline in the national rate of normal BMI between 2020 and 2022, dropping to 47.5%, below the target of 51%. In the health districts, District 4 reported a lower-than-target normal BMI rate of 47.38% during the same period. Additionally, the waist circumference situation in working-age populations in District 4 followed a similar trend, with a rate of 57.06% in 2022, meeting the target of $\geq 53\%$ (Health Information Group, Strategy and Planning Division, Office of the Permanent Secretary, Ministry of Public Health, 2022).

The researcher chose to study the working-age population in Phra Nakhon Si Ayutthaya Province, located in Health District 4. According to 2021 data from the Industrial Business Information Center, there are 611 factories in the area, with a working-age population of 158,689. The 2023-2026 health check-up reports show that the percentage of the working-age population with a normal BMI in Phra Nakhon Si Ayutthaya has fluctuated between 48.11% and 49.76%. In 2023, the highest rates of overweight were found in Uthai District (26.96%), Phak Hai District (25.20%), and Bang Sai District (24.99%). Given these statistics, the researcher is interested in developing a health promotion model for overweight working-age individuals using mHealth in Phra Nakhon Si Ayutthaya Province. The model is based on Bandura's Self-Efficacy Theory (1997) and Rogers' Protection Motivation Theory (1983). This model aims to design interventions that promote long-term behavioral changes in diet and physical activity, with continuous communication and health outcome tracking through artificial intelligence (AI)-enabled mobile health (mHealth) technologies. The study will follow a three-phase Research and Development process: Phase 1: Diagnosis of the situation, Phase 2: Design and development of the model, and Phase 3: Testing and evaluation of the model. The expected outcome is that working-age individuals with overweight will be able to make sustainable improvements in their health behaviors, leading to better health outcomes in the long term.

2. Objectives

1. To study the health behaviors and weight loss needs of overweight working-age individuals in Phra Nakhon Si Ayutthaya Province.
2. To develop a health promotion model for overweight working-age individuals using mHealth in Phra Nakhon Si Ayutthaya Province.
3. To evaluate the effectiveness of the health promotion model for overweight working-age individuals using mHealth in Phra Nakhon Si Ayutthaya Province.

3. Methodology

This study is a research and development (R&D) project conducted from May to September 2024. It involves a 4-week activity followed by a 6-week post-experiment phase. The research is divided into three phases:

Phase 1: Situation Analysis and Weight Loss Needs Among Overweight Working People. This phase will be carried out from May to June 2024. The study population includes working individuals who are overweight (BMI 23-25 kg/m²), totaling 41,660 people, or 20.78% of the working-age population of 404,690 (Department of Health, as of November 16, 2022 and Siddique, J. 2012). A sample of 110 individuals will be randomly selected from employees at three factories using a proportionate random sampling method. Additionally, 9 key informants will be selected from the same factories, including 6 human resources staff and 3 staff members responsible for health promotion, all with at least 5 years of experience in health promotion for overweight workers. The research tools include qualitative data collection instruments, such as in-depth interviews to explore, 1) Factors affecting the health of overweight working people, 2) Preventive behaviors related to excess weight, including, eating behaviors, Exercise behaviors, Environments conducive to preventing excess weight, Needs and participation in preventing excess weight and Weight loss strategies related to diet and physical activity suitable for individuals. The data collection tools also include, A personal information questionnaire (11 questions), covering gender, age, marital status, education, occupation, family monthly income, and pre-program behaviors regarding food and physical activity. Health status data collection tools including weight, BMI, muscle mass, fat mass, and resting energy expenditure, measured with the Tanita DC-360 Bioelectrical Impedance Analyzer, A motivation questionnaire assessing: 1) Perceived risk of excess weight (20 items), 2) Perceived severity of excess weight (20 items), 3) Perceived benefits of behavioral changes related to food and exercise (5 items), 4) Perceived barriers to behavioral changes (5 items)} 5) Long-term motivation to change food and exercise behaviors (5 items). The responses are on a 5-point Likert scale. A questionnaire assessing long-term behavioral change effectiveness related to food and exercise based on self-efficacy theory (Bandura, 1997), including 10 positive questions on a 5-point scale,

with scores ranging from 10 to 50. The perceived self-efficacy is categorized as low (10-23), moderate (24-37), and high (38-50). Content validity is confirmed with a Content Validity Index (CVI) greater than 0.8 for all questions (Davis, 1992), and reliability was tested with a Cronbach's alpha of 0.940 through a pre-test with 11 participants similar to the study population.

Phase 2: Development of a Health Promotion Model for Mobile Application Intervention Among Overweight Working People. This phase will take place from June to July 2024, consisting of two steps: 1) Health risk assessment. 2) Self-efficacy assessment. The activities include: "You Are What You Eat" – preparing healthy food, "You Get What You Do" – receiving rewards for efforts, "The Power of Persuasion" – using influential figures to encourage weight loss and "Believe in Yourself" – building self-efficacy.

Phase 3: Implementation and Evaluation of the Health Promotion Model for Mobile Application Intervention Among Overweight Working People. This phase will occur from July to September 2024 and will test the health promotion model with mobile application modifications. The experiment will involve 72 participants (36 in the intervention group and 36 in the comparison group) for 4 weeks. The evaluation will include pre- and post-test measures using questionnaires to assess eating behaviors, exercise habits, weight, BMI, muscle mass, fat mass, and energy expenditure. Data will be collected as follows: 1) Pre-intervention: Collect data from 72 overweight working people in the experimental and comparison groups. 2) Intervention period: The experimental group will participate in 4 sessions, 1) Learning from personal success stories in long-term behavior change (60 minutes). 2) Goal setting for long-term behavior change in diet and exercise (120 minutes) with clear, measurable, achievable, realistic, and time-bound goals. 3) Self-monitoring and recording behaviors (60 minutes) with 6 steps for tracking changes. 4) Self-assessment to evaluate goal achievement over 4 weeks. The research tools will include questionnaires from Phase 1 (situation analysis and weight loss needs). Data analysis will employ descriptive statistics, dependent t-tests, and independent t-tests for comparing the experimental and control groups, with statistical significance set at $p < 0.05$.

4. Results

Phase 1: Situation analysis and needs of weight loss among overweight working adults. The research findings on quantitative data related to personal information, health status, motivation levels, and long-term behavioral changes in eating and exercise habits were collected from 110 overweight working adults. The results show that the majority of employees in the three factories are male (54.5%). The largest age group of overweight workers is 29-34 years, accounting for 29.1%, followed by 23-28 years at 20%. The average age (\pm standard deviation) of employees in this group is 37.18 ± 9.83 years, with the youngest employee being 23 years old and the oldest being 58 years. The most common marital status is single (41.8%), followed by married (37.3%). Most employees have less than a bachelor's degree (59.1%), while 39.1% have a bachelor's degree. Monthly income is mostly in the range of 15,001-20,000 baht (33.6%), followed by 10,000-15,000 baht (32.7%). A majority of employees (61.8%) follow a diet emphasizing vegetables, fruits, grains, and dairy products, aligning with the Mediterranean Diet, which promotes healthful, nutritious foods. Another 28.2% of employees manage their weight by counting calories, a common weight-control method that restricts energy intake. Diets such as the Atkins Diet and the Paleo Diet are used by 4.5% of employees each, while 0.9% follow the Intermittent Fasting (IF) method, which includes designated eating and fasting periods. No employees reported using the Ketogenic Diet or any other unspecified eating pattern. Regarding physical activity, most employees (58.2%) do not exercise or sit at their desks all day, which may lead to weight gain due to the lack of energy expenditure from physical activity. About 32.7% engage in light exercise 1-2 times a week, which may not be sufficient for health maintenance or weight control. Only 9.1% of employees exercise moderately 3-5 times a week. No employees report engaging in heavy exercise (6-7 times per week) or intense exercise (daily, twice a day). Most employees (61.8%) have a BMI classified as obese, with 76% of women and 28.33% of men having high muscle mass. Overweight workers (60%) intend to lose weight in the future but have not yet started, while 30% are already engaged in weight-loss activities. A small group (10%) has no intention of losing weight and may require additional motivation or support for health management. For those interested in weight loss through mHealth, they are keen

to use health promotion models designed for overweight working adults. These models aim to change eating and physical activity behaviors in the long term, using mobile health technologies (mHealth), AI-driven communications, and health tracking through platforms like YouTube. From qualitative data gathered from key informants, it was found that working adults in Factory A face environmental and behavioral factors that influence their eating and exercise habits. To promote sustainable weight loss and good health, improvements in both workplace and home environments are needed. Activities and policies implemented in the workplace play a crucial role in encouraging employees to lose weight, especially through the use of technology and mHealth applications for monitoring and advising. These tools have significantly influenced behavioral changes in eating and exercise habits. Therefore, developing a health promotion model to modify mobile applications for overweight working adults should focus on education, supporting activities, modern technologies, improving supportive environments, and establishing strong policy frameworks to ensure sustainable and effective health promotion.

Phase 2: Development of a Health Promotion Model for Modifying Mobile Applications Among Overweight Working People in Phra Nakhon Si Ayutthaya Province. The development results in this phase indicate that the health promotion model for modifying mobile applications for overweight working people in Phra Nakhon Si Ayutthaya Province includes an application with six functions, (1) Energy calculation, (2) Food menu and energy information, (3) Menus for working adults, (4) Summary data, (5) Current achievements, and (6) Profile and usage history. This application is designed for mobile devices, specifically smartphones with the Android operating system. The prototype draft for mHealth intervention, tailored for overweight working adults, includes two key processes: (1) Health risk assessment and (2) Self-efficacy assessment, as shown in Figure 1.



Figure 1.
Development of a health promotion model for modifying mobile applications.

Training/Providing Information/Organizing Learning Activities: Learn from a 1–2-hour video clip by a famous YouTuber doctor, summarize the knowledge gained from the 1–2-hour video, and engage in a 1-hour discussion to exchange opinions on modifying eating habits and exercise behaviors. Additionally, there will be a 1-hour introduction to using the mHealth weight loss program, followed by 1 hour of members using the program and providing feedback according to the mHealth weight loss program.

Phase 3: Implementation and Evaluation of a Health Promotion Model for Modifying Mobile Applications Among Overweight Working People. Part 1: Demographic Information This study involved 72 participants, equally divided between the experimental group and the comparison group (n=36 per group). The demographic characteristics of both groups are as follows: the experimental group consisted of 53.3% women and 46.7% men, while the comparison group had a higher percentage of women (71.1%) and men (28.9%). This difference may influence the study's behavioral outcomes, as

women and men may respond differently to weight loss programs. The average age of the experimental group was 31.96 years, compared to 37.18 years in the comparison group. This age difference may affect participants' perceptions and adherence to the weight loss program, as adaptability and motivation can vary by age group. The experimental group had a higher percentage of singles (53.3%), while the comparison group had a significantly higher percentage of widowed/divorced/separated individuals (17.8%), which may affect the social support for weight loss behaviors. Both groups predominantly had education levels below a bachelor's degree, with 53.3% in the experimental group and 42.2% in the comparison group. However, the comparison group had a higher percentage of individuals with master's and doctoral degrees (6.7% and 6.7%, respectively), which could influence perceptions and adherence to the program. The comparison group also had a higher percentage of individuals earning 15,001–20,000 baht (57.8%) compared to the experimental group (42.2%), which may impact access to quality food and health promotion activities.

Part 2: Comparison of Eating Behaviors The majority of participants in both groups lacked clear eating patterns (75.6% in the experimental group, 68.9% in the comparison group), which is a challenge for weight loss. However, the comparison group had a higher proportion of individuals following a Mediterranean diet (28.9%) compared to the experimental group (17.8%), potentially reflecting a greater health-consciousness. In terms of exercise behaviors, both groups had similar proportions of individuals who did not exercise or worked in office settings, with 55.6% in the experimental group and 57.8% in the comparison group. The percentage of participants engaging in light exercise was also similar (40%), with the experimental group showing a slightly higher proportion (4.4%) compared to the comparison group (2.2%).

Part 3: Intervention Model for the Experimental Group The experimental group received a health promotion model for overweight working individuals using a mobile application (mHealth) in two stages: 1) Health risk assessment, including self-understanding, and 2) Self-efficacy evaluation, which involved goal setting, self-monitoring, and self-assessment. Four activities included in the program were: *You Are What You Eat*, *You Get What You Do*, *The Power of Persuasion*, and *Believing in Yourself Matters*. **Post-Intervention Results:** After participating in the health promotion activities, the experimental group demonstrated significantly higher awareness of the risks associated with overweight ($t = 6.16$, $p\text{-value} < .001$), motivation to change behavior ($t = 8.30$, $p\text{-value} < .001$), and self-efficacy ($t = 7.48$, $p\text{-value} < .001$) compared to pre-intervention. They also reported fewer perceived barriers to behavioral change ($t = 4.75$, $p\text{-value} < .001$). Following the intervention, the experimental group showed improved eating behavior ($t = 7.69$, $p\text{-value} < .001$), increased physical activity ($t = 7.36$, $p\text{-value} < .001$), weight loss ($t = 21.33$, $p\text{-value} < .001$), and increased muscle mass ($t = 8.41$, $p\text{-value} < .001$), all with statistical significance. However, there were no significant changes in fat mass ($t = 2.11$, $p\text{-value} = .055$) or metabolic rate ($t = 0.68$, $p\text{-value} = .499$). The comparison group showed no significant differences in eating behavior ($t = 0.245$, $p\text{-value} = .732$), physical activity ($t = 1.70$, $p\text{-value} = .066$), body weight ($t = 1.27$, $p\text{-value} = .209$), muscle mass ($t = 0.806$, $p\text{-value} = .425$), fat mass ($t = 0$, $p\text{-value} = 1.00$), or metabolic rate ($t = 1.00$, $p\text{-value} = 0.323$) after two weeks.

Part 4: Analysis of the Study The results showed that the experimental group had improved eating behaviors, physical activity, body weight, muscle mass, fat mass, and metabolic rate compared to the comparison group, as determined by analysis of covariance (ANCOVA). Post-intervention, the comparison of average eating behavior showed a significant statistical difference ($F = 28.18$, $p\text{-value} < .001$). The analysis also revealed that pre-intervention body weight significantly influenced post-intervention weight ($F = 4580.27$, $p\text{-value} < .001$), with a significant difference in body weight after the intervention ($F = 406.60$, $p\text{-value} < .001$). Similarly, muscle mass and fat mass were significantly impacted by pre-intervention values, indicating that baseline measures played a role in post-intervention outcomes. Fat mass did not show a significant difference after the intervention ($F = 3.74$, $p\text{-value} = 0.056$), though muscle mass increased significantly ($F = 4.38$, $p\text{-value} = 0.039$).

5. Conclusions

The development of a health promotion model through mobile applications (mHealth) for overweight working adults in Phra Nakhon Si Ayutthaya Province applied the Motivation Theory (Rogers, 1983) and Self-Efficacy Theory (Bandura, 1997) in a two-step process: 1) health risk assessment, incorporating cognitive mediation processes, including self-awareness, and 2) coping

responses, which include goal-setting, self-monitoring, self-assessment, and four key activities: "You are what you eat," "You get what you do," "The Power of Persuasion," and "Believing in yourself matters."

The results of participation in the health promotion activities showed that the experimental group exhibited improved cognitive processes as expected, including risk awareness, perceived severity of overweight, perceived benefits and barriers to behavior change, motivation, and self-efficacy for behavior modification. These results can be discussed based on the research hypotheses.

After the intervention, the experimental group demonstrated better eating habits and physical activity than before the experiment and outperformed the control group. This suggests that after receiving information from the mHealth application, the experimental group processed risk awareness, perceived severity of overweight, benefits and barriers to behavior change, motivation, self-efficacy, and responses to experiences (cognitive mediating processes). They accepted the desired behavior change (adaptive response). The influence of the mHealth application served as a medium to stimulate cognitive mediation processes and guide behavior, resulting in compliance with the recommendations and improved eating habits and physical activity as hypothesized. According to Rogers, individuals will follow recommendations based on their perception, leading to adaptive responses or desired health behaviors. The health promotion model for overweight working adults included four core activities: 1) self-assessment and learning from personal successful experiences, 2) setting clear behavior change goals (SMART Goals), goal commitment, and motivation for action, 3) self-monitoring of behavior practices, and 4) self-evaluation based on goals. After the intervention, the experimental group showed improvements in weight and muscle mass compared to before the experiment and compared to the control group. This indicates that improved eating habits and physical activity contributed to the experimental group achieving better weight and muscle mass outcomes. The improved physical activity resulted from behavior changes based on the mHealth application, which stimulated awareness and adaptation according to cognitive mediation principles. Continuous support and information from the app facilitated behavior changes, leading to regular and more effective physical activity. Physical activity helps burn calories and promotes muscle growth, while proper nutrition ensures the body receives essential nutrients. Together, these factors reduce excess weight and strengthen muscles. The physical activities adopted were simple and consistent, such as brisk walking, which is an easy and convenient exercise that does not require equipment and can be done daily to promote energy expenditure and heart health. Walking for 30 minutes a day stimulates metabolism and strengthens overall physical health. Low-impact aerobics, such as light aerobic dancing, helps individuals engage in physical activity without putting undue strain on joints or muscles. Stretching regularly increases flexibility and reduces the risk of injury. Stretching for 10-15 minutes per day alleviates pain and enhances muscle health. No differences in body fat percentage or metabolic rate were found within or between the groups. This study suggests that dietary behavior changes accompanied by physical activity may not be sufficient to affect body fat and metabolic rate improvements in the short term. It may take more time to see significant differences. Further studies should consider other factors or enhance the effectiveness of the health promotion model. A more intense and continuous exercise program may be needed to reduce body fat and increase metabolic rate for clearer health outcomes. Other factors, such as individual differences in health response, may not have been adequately controlled in this study. Similar research, such as the PREMIER study, examined weight loss and blood pressure control in high-risk adults for cardiovascular disease, incorporating nutrition advice, increased physical activity, and health behavior changes. The intervention group showed significant weight loss and lower blood pressure than the control group, suggesting that comprehensive and continuous interventions can lead to significant changes in behavior and health status (Elmer et al., 2006). The Diabetes Prevention Program (DPP) study, which focused on reducing diabetes risk in prediabetic individuals, also demonstrated that dietary and exercise modifications, along with weight loss support, significantly lowered diabetes incidence and improved health behaviors (Knowler et al., 2002).

Other studies, such as those by King et al. (2000), found that promoting exercise could increase physical activity in the short term but did not result in significant differences in health indicators like weight or BMI compared to the control group. The study by Spring et al. (2012) showed that a digital

intervention to promote healthy eating did not lead to significant health indicator changes, such as weight. The study by Lombard et al. (2016) and Wichai, E. (2010) showed no significant differences in weight and other health indicators between the intervention and control groups. Similarly, Spring et al. (2013) found that mHealth helped with weight loss and increased physical activity significantly but did not impact other areas like eating behavior. Other studies have similarly shown that short-term interventions may not lead to clear health changes, reinforcing the need to improve or intensify health promotion programs for future clearer outcomes in health status and behavior changes.

6. Recommendations

1. The health promotion program should be improved or enhanced to ensure clear changes in these areas. The mHealth program should be refined to include specific nutritional or exercise guidance to increase the effectiveness of behavior change in participants.
2. Consider extending the duration of the intervention to allow for clearer results.
3. Additional methods, such as group activities or continuous support, should be considered to enhance motivation for behavior change and reduce barriers to behavior modification.
4. The research tools or program design should be improved to better suit the target group and conditions being studied, in order to accurately reflect changes in health behaviors and health status.

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