



# Psychological Mechanism of Weight-Loss among Chinese Female College Students

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## Abstract

**Objectives:** Given the high pressure of weight-loss face by Chinese female college students and the lack of studies on the psychological mechanism of the weight-loss behaviors of this particular group, the present study investigated the interrelationships among the planning, self-regulation, and volitional self-efficacy, which were identified as the most significant three factors influencing the weight-loss of this population.

**Methods:** Five hundred (n=500) female college students were recruited from three colleges in China. The collected data include participants' planning, self-regulation, volitional self-efficacy, and weight-loss result. Wen, Zhang, Hou, & Liu's (2004) three-step procedure was adopted to test the mediating effects of self-regulation and volitional self-efficacy, respectively, between planning and weight-loss result.

**Results:** The mediating effects of self-regulation and volitional self-efficacy were confirmed. Based upon those, a recursive model was proposed to show a joint impact from the interrelated planning, self-regulation, and volitional self-efficacy to weight-loss result.

**Discussion:** This study gained an in-depth understanding of both direct and indirect influences between planning to weight-loss. The recursive model sheds light on the potential promoting effect of the planning to weight-loss result through an enhanced self-regulation and volitional self-efficacy. The found psychological mechanism of Chinese female college students' weight-loss behaviors pave the road for the studies of intervention.

## Introduction

Overweight and obesity are worldwide-recognized health problems which affect people's lives [1]. In addition, they have also been found to be the causes of 20 other diseases. Worldwide, reports show women have greater rates of obesity and overweight than men. A longitudinal study conducted in a Swedish context showed that the desire of weight-loss of women is higher than men regardless of their age and weight [2]. The data in China echo the global trend and indicate that 40% to 79% female college students intend to lose weight [3, 4,5]. In Song, Xiao, Li, Jin, Huang, Zhang, Duan, &

Xu's (2012) investigation of overweight in Chinese college contexts, 43% of the total participants identified as overweight are female students, which is significantly higher than the 23% of male students. This finding suggested that female college students are facing a higher pressure for losing weight from the society, and this pressure they have stronger need and are struggling to lose weight.

Over the past decades, several models were proposed to understand the health-related behaviors. These models include Health Belief Model [6], Theory of Planned Behavior [7], Model of Action Phases [8,9], etc. Among these models, Health Action Process Approach (HAPA), proposed by Schwarzer [10], considers health action as a reversible process which falls into motivational and volitional phases. In Li, X., Yang, L., Wang, A., & Zhang, Y. [11] study on Chinese female college students' beliefs on weight-loss, planning, self-regulation, and volitional self-efficacy were identified as the three most significant factors influencing their weight-loss action. Although weight-loss behavior is found with different stages and influenced by various factors, how these factors are interrelated during the volitional phase is still understudied. Given the significant needs of weight-loss faced by Chinese female college students and the lack of studies on the psychological mechanism of weight-loss, the current study aims to investigate the interrelationships among the identified factors through proposing a recursive model.

Weight-loss, which is deemed a dynamic process of human behavior, includes a series of stages [12]. The Health Action Process Approach (HAPA) model of Schwarzer [10] has been widely adopted as a stage model of behavior change to study the issues of obesity and overweight [11]. HAPA divides the weight-loss action into two phases, motivation and volition according to Duan et al. [13]. The motivational phase accounts for the action of choosing to lose weight. Although motivation forms intention, the well-motivated intention does not necessarily lead to action [14]. With the intention set up, volitional phase explains to what extent the weight-loss action can be maintained through planning, strategies, and individual abilities. The formation and maintenance of the intentions are influenced by multiple factors. Within the motivational phase, intentions are influenced by self-efficacy, expectation of outcomes, and threat

[15,16]. Different from their roles in the motivational phase, expectation and threat have little impact on volition. Rather, the volition of weight-loss is largely determined by specific planning. In addition to a well-designed plan, strong volitional self-efficacy is needed to ensure the planning can be converted to action.

Based on the HAPA model, Li et al. [17] found that the most significant three psychological factors influencing female Chinese college student in losing weight include planning, volitional self-efficacy, and self-regulation. Previous studies (e.g. [18]) using the HAPA model have confirmed that planning is a crucial factor transforming intention to action. Volitional self-efficacy determines the extent and persistence of ones' dedication to weight-loss. Compared to the other two factors, self-regulation had the most significant impact on one's weight-loss action. The present study, taking HAPA as the theoretical foundation, continues Li et al.'s [19] study to investigate interrelationships among the planning, volitional self-efficacy, and self-regulation. The psychological mechanism examined in the present study can be promising in providing rationale for future psychological intervention to the target population.

A well-designed weight-loss plan provides the foundation for the implementation of action planning. Assuming the people with obesity have already been motivated to lose weight, the process of maintaining weight-loss is seen as the volitional phase of restructuring healthy behaviors. The volitional phase is subdivided into the intention stage and the action stage. In transforming intention to action, planning serves as a mediating variable between these two stages [20]. In other words, when an individual has a detailed plan, he or she is more likely to take action. When proposing the HAPA model, Schwarzer [10] specified two types of planning: action planning and coping planning. They both serve as the mediators to ensure action continues being driven by intention but they function differently. Action planning is not a simple extension of intention. It specifies context and procedure for an individual to follow to maintain weight-loss action. Coping planning is equally important as it offers the individual with alternative plans to overcome potential barriers encountered over the weight-loss process [21]. Although action planning and coping planning work differently, they both play crucial roles in keeping an individual moving forward with planned behaviors rather than reverting back to original behaviors [22]. The positive synergistic effect of both action and coping planning to the changes of action was confirmed by Wiedemann, et al. [23].

As another factor influencing the implementation of action planning, volitional self-efficacy determines the degree of effort and persistence. Those with high volitional self-efficacy are more likely to be able to visualize success to persevere when encountering obstacles. In contrast, those with low volitional self-efficacy will be more inclined to visualize expected scenarios of failure and give up prematurely. According to O'Leary [24], individual with high volitional self-efficacy can recover in a fast fashion even faced with unpredicted difficulty. Thus, because of perseverance during difficult times and fast recoveries through frustration, individuals with higher volitional self-efficacy, compared with those with low volitional self-efficacy, are believed to have stronger capacities to accomplish their goals. Previous studies have also found the development of one's volitional self-efficacy is dependent upon multiple factors including personal experience of success and failure in weight-loss, vicarious experience of others' success, and self-guiding speeches [25]. With that being said, in the beginning process of planning weight-control, both others' successful experience along with personal experience should be taken into consideration. In addition, self-guidance, as one type of self-regulating abilities, is also an effective strategy. Therefore, both planning and self-regulation are effective in promoting one's volitional self-efficacy.

In the process of carrying out a weight-loss plan, self-regulation

is important to keep an individual on track. Self-regulation has been rarely studied as the most important factor mediating intention and action. As Gollwitzer and Bayer [26] assert, intention cannot account for its subsequent action. Kuhl [27] offers a core hypothesis of self-regulation: an individual's strong belief may help activate his or her volitional self-efficacy, but the individual may not have the capability to carry out the planning and eventually achieve the goal. For examples of daily exercises, self-regulation is required to keep an individual from distractions and ensure the plan is carried out. In order to keep healthy, someone must be self-regulated with great efforts to stick to a plan, as well as have great volition and proper guidance. If an individual wants to control the consumption of snacks, controlled action is imperative to effectively restrain one's desire under high pressure. These examples show self-regulation is a crucial ability that may turn an intention to an accomplishment.

Self-regulation is needed once an individual starts taking action because it helps avoid termination of planned behaviors due to a lack of confidence or any interruption. An individual needs metacognitive monitoring to prevent other behavioral tendencies that could interfere with weight-loss. For instance, when exercising, an individual needs to monitor his or her own behaviors, such as eating habit, social media use, or sleep. Thus, the more metacognitive skills and internal coping strategies are developed, the more likely it is an individual can handle emergencies and eventually achieve the goal [28, 29].

Based on the discussion of the three psychological factors (i.e., planning, volitional self-efficacy, and self-regulation), the present study is intended to investigate the interrelationships among these factors, and their impacts on weight-loss behaviors in order to gain an in-depth understanding of the psychological mechanism of the weight-loss behavior. In exploring the interrelationships, three hypotheses are proposed as following: (1) planning has a positive impact on volitional self-efficacy through promoting self-regulation; (2) planning has a positive impact on effect of weight-loss through promoting volitional self-efficacy; (3) planning, self-regulation, and volitional self-efficacy work jointly to influence the effectiveness of weight-loss.

## Methodology

### Participants

Five hundred ( $n = 500$ ) female college students who had attempted weight-loss in the past were randomly selected from 3 different colleges located in two large cities in Northeastern China. Body Mass Index (BMI) was measured for each participant. Of the 500 participants, 89 of them had a BMI greater than 24, indicating obesity or overweight. The other 411 participants were considered to have a "normal" BMI which falls in the healthy range between 18.5 to 24.0 as defined by the World Health Organization [30].

### Instruments

*Measure of weight-loss plan.* The weight-loss plan was measured by the Obesity Prevention Plan Scale [11]. The plan scale contains two dimensions (i.e. action planning and coping planning) and nine items. Responses on the survey were made on a four-point Likert scale ranging from 1 to 4, 1 being not consistent or true at all whereas 4 was considered to be very consistent or completely true. A higher score indicates a more sophisticated plan. An example question from the instrument asks if participants plan to learn about and buy weight-loss products. The reliability of the overall instrument ( $\alpha = .84$ ) and its two subscales: action planning ( $\alpha = .75$ ) and coping planning ( $\alpha = .82$ ) were found satisfactory.

*Measure of Self-regulation.* Self-regulation was measured by the Obesity Prevention Self-Regulation Scale [11]. The self-regulation scale consists of two dimensions, emotion self-regulation and behavior self-regulation. The responses were measured based on a 4-point Likert scale with a higher score indicating a stronger sense of self-regulation. An example question from the instruction asks if

participants self-regulate their own emotions when finding the effect of weight-loss is not significant. The scale was found with satisfactory reliability within both the overall instrument ( $\alpha=.83$ ) and its two subscales: emotion self-regulation ( $\alpha=.84$ ), and behavior self-regulation ( $\alpha=.63$ ).

**Measure of Volitional self-efficacy.** Volitional self-efficacy was measured by the Obesity Prevention Volitional Self-Efficacy Scale [11]. Volitional self-efficacy contains two dimensions, maintaining volitional self-efficacy and recovery volitional self-efficacy. The same 4-point Likert scale was used to measure participants' responses. A higher score means a higher level of volitional self-efficacy. An example question from the instrument asks if participants persist to excise even there is no instant effect from weight-loss action. The reliability was found satisfactory within the overall instrument ( $\alpha=.88$ ) and its two subscales: maintain volitional self-efficacy ( $\alpha=.80$ ), recovery volitional self-efficacy ( $\alpha=.88$ ).

**Measure of Weight-Reducing Effect.** The amount of energy storage was evaluated to measure weight loss. The Energy Storage Index is the difference between energy intake and energy consumption. The smaller the amount of energy storage, the better the weight-loss effect. Higher energy storage represents an ineffective weight loss control [31]. Basal metabolism, thermic effect of food, and physical activity all measured energy expenditure. The Schofield equation, thermal efficiency, and International Physical Activity Questionnaire [32] were adopted to measure the three aspects of energy expenditure.

#### Data collection

Data collection took place during a class session. Before the

collection started, an introduction on the purposes and procedure of the study was provided to all students. Based on a clear understanding of the study, consent forms were signed by participants on a volunteer basis. Then, a survey assessment was administered to each participant. Surveys were collected in the classroom when participants finished. Over the entire process, there was no discussion among participants.

#### Data Analysis

Data analysis included three steps in the present study. Foremost, correlation and multiple linear regression analysis was conducted among the three independent variables (i.e. planning, the self-regulation plan, and the volitional self-efficacy plan). Second, the mediating effects of (a) self-regulation between plan and volitional self-efficacy and (b) volitional self-efficacy between plan and weight-loss result were examined. Lastly, path analysis was conducted to test the proposed recursive model which was built based upon the two found mediating effects.

## Results

### Correlation among variables

Spearman correlation analysis (Table 1) indicated that there were significant correlations between weight-loss result and planning ( $r = -.11, p < .01$ ), self-regulation ( $r = -.18, p < .01$ ) and volitional self-efficacy ( $r = -.18, p < .01$ ) respectively. In addition, significant relations were found between planning and both self-regulation ( $r = .66, p < .01$ ) and volitional self-efficacy ( $r = .66, p < .01$ ). This suggested a predictive relationship among variables, which demands further analysis.

Variable	M	SD	Weight-Loss	Planning	Self-Regulation
Weight-loss Result	-878.55 (Kcal)	866.99	-		
Planning	2.42	.58	-.11**	-	
Self-regulation	2.64	.59	-.18**	.66**	-
Volitional self-efficacy	2.71	.65	-.18**	.66**	.72**

Note: \*\*  $p < .01$

Table 1. Correlation among weight-loss result, plan, self-regulation, and volitional self-efficacy ( $n = 500$ ).

### The mediating effect of self-regulation

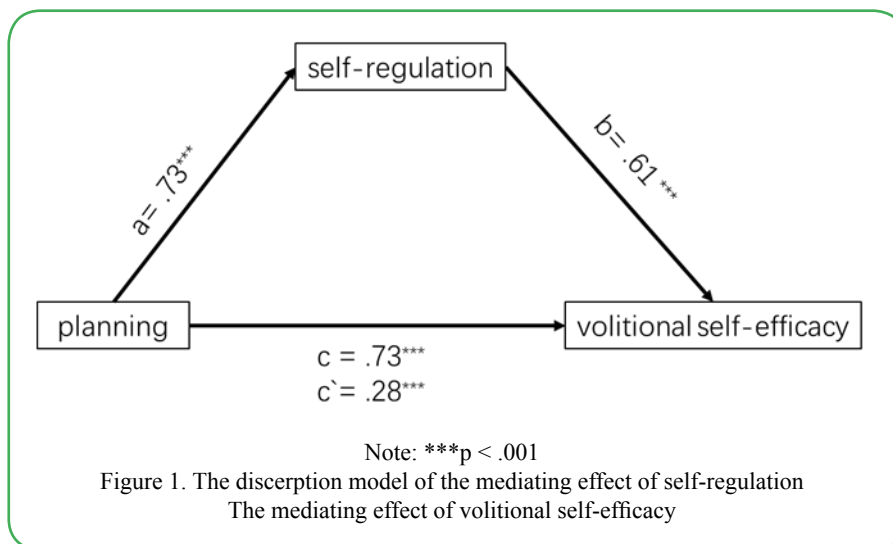
According to Wen, et al. [33] procedure for examining the mediating effect of a focused variable, a model was set to investigate the potential mediating effect of self-regulation which lies between planning and volitional self-efficacy. Wen et al.'s [33] procedure consists of three steps. In this case, as shown in both Table 2 and Figure 1, they work together to test the consistency in the correlation (i.e.  $c$  &  $c'$ ) between the beginning (i.e. planning) and terminal factor volitional self-efficacy before and after when the factor hypothesized with mediating effect (i.e. self-regulation) is added. First, it was found that the coefficient  $c$  from planning to volitional self-efficacy is significant. This indicates a positive prediction effect of planning to

volitional self-efficacy. Second, it was found that both the coefficient  $a$  from planning to self-regulation and the coefficient  $b$  from self-regulation to volitional self-efficacy were significant. Third, based on the aforementioned significance, the coefficient  $c'$  from planning to volitional self-efficacy was still found to be significant. Through this process, the mediating effect is confirmed. It is also confirmed that planning can predict volitional self-efficacy through self-regulation. Based on the result above, hypothesis 1 was supported. Through the examination of the mediating effect of self-regulation, planning was found to have a positive impact on volitional self-efficacy through promoting self-regulation.

Steps	Focused path	$\beta$	S.E.	$t$
Step 1	$c$	.73	.031	23.53***
Step 2	$a$	.73	.022	24.05***
Step 3	$b$	.61	.033	17.06***
	$c'$	.28	.035	7.65***

Note: \*\*\* $p < .001$

Table 2: The examination of the mediating effect of self-regulation



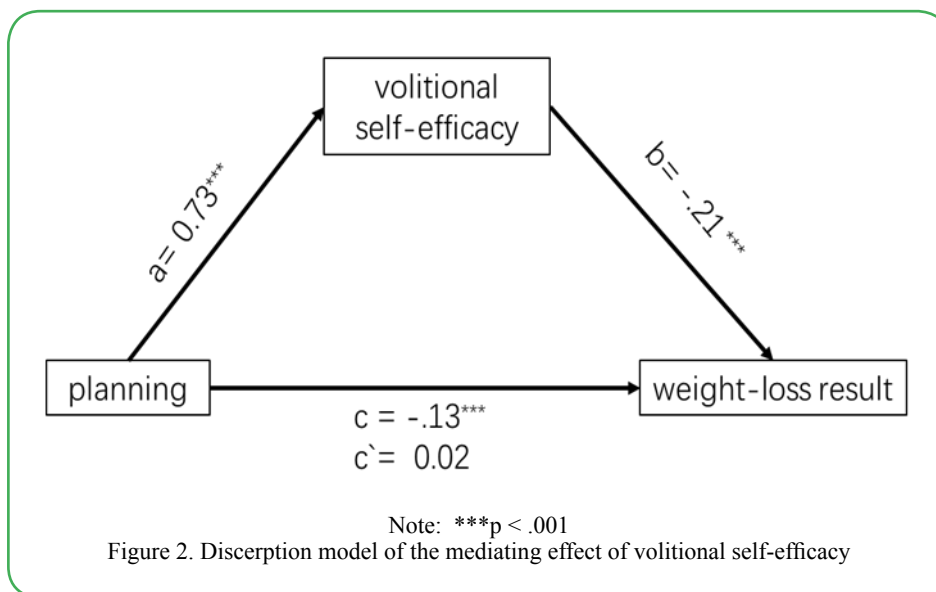
To investigate the mediating effect of volitional self-efficacy, the same examination of mediation was conducted in a model which consists of planning, volitional-efficacy, and weight-loss result. As indicated in Table 3 and Figure 2, the significant coefficient from planning to weight-loss result showed that a well-designed plan can predict weight-loss result. Second, it was found that *a*, the coefficient between volitional self-efficacy and planning, and *b*, the coefficient between volitional self-efficacy and weight-loss result, are both

significant. Last, the coefficient *c'* was still found to be significant after the volitional self-efficacy as the hypothesized mediating factor was added between planning and weight-loss result. Based on the result above, hypothesis 2 was supported. Through the examination of the mediating effect of volitional self-efficacy, planning was shown to have a positive impact on the effect of weight-loss through promoting volitional self-efficacy.

Step	Focused path	$\beta$	S.E.	t
Step 1	c	-.13	.040	-2.90***
Step 2	a	.73	.023	23.5***
Step 3	b	-.21	.063	-3.23***
	c'	.02	.063	.33

Note: \*\*\*p < .001

Table 3: The examination of the mediating effect of volitional self-efficacy

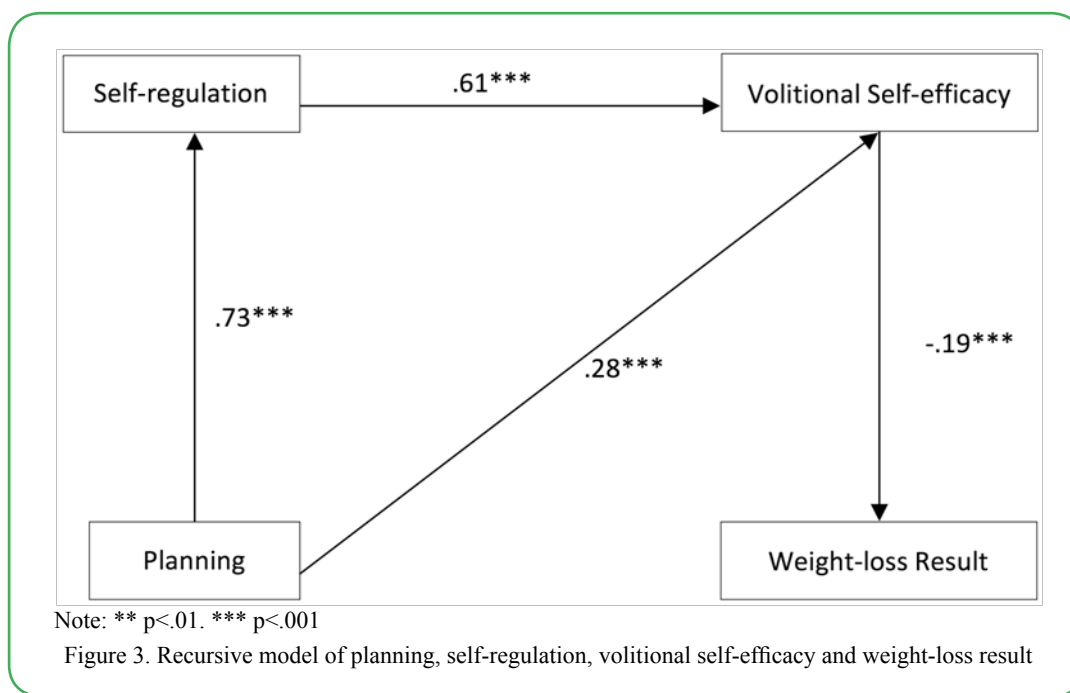


**Recursive model test**

Based on the previous results (i.e. the mediating effect of self-regulation between plan and volitional self-efficacy, and the mediating effect of volitional self-efficacy between planning and weight-loss result), a recursive model is hypothesized (Figure 1) with

these two subordinate relationships added together. Indices, including TLI, CFI, and RMSEA, were used to evaluate the goodness of fit of the final model [34,35,36]. The results showed the recursive model test fit well (Table 4).





n	$\chi^2$	df	$\chi^2/df$	p	TLI	CFI	RMSEA
500	4.560	2	2.28	.10	.992	.997	.051

Table 4 : Selected measures of goodness of fit of the final model

As shown in Figure 1, the recursive model successfully embraces the relationships tested in the two subordinate models. The significance was found in both the indirect effect of plan to volitional self-efficacy  $.45 (.73 \times .61, p < 0.05)$  as well as the direct effect ( $p < .05$ ). This confirms hypothesis 1 that the plan exerts indirect impact on volitional self-efficacy via self-regulation. In addition, hypothesis 2 was also confirmed in the recursive model in regards to the significant indirect effect from plan to weight-loss result  $(.73 \times .61 \times .19 = -.139, p < .05)$ .

## Discussion

### Venues to promote volitional self-efficacy

The present study found that the volitional self-efficacy could be promoted through two venues: planning through promoting self-regulation and direct promoting effect from planning. Bandura [37] explained that one's experience of success and failure is the most important factor influencing self-efficacy. People with successful experiences would view themselves as having ability, while those who fail would view themselves as lacking ability. The present study found self-regulation can positively predict self-efficacy. People with higher level of self-regulation tend to have greater self-efficacy. Surely, it needs to be recognized that self-regulation is not exclusively developed congenitally but also acquired through practices. The present study found self-regulation can be promoted by quality planning: first, action planning can guide self-regulation by specifying when and where things need to be done; second, coping planning provides strategic resources which help adjust behaviors in emergency. In addition, another venue lies in the direct promoting effect from planning to self-efficacy. Bandura [37] claimed that self-efficacy could be inspired by role models. In many cases, planning is influenced by modeling of people who are successful in weight-loss. Thus, coping planning is grounded in the predicted difficulties.

### Mediating role of volitional self-efficacy

In the HAPA model, volitional self-efficacy is assumed to remain consistent without changing along with success or failure of individual experience. With that being said, volitional self-efficacy is deemed an external factor. According to Bandura [37], volitional self-efficacy is a dynamic variable which can be improved through direct experiences of success and failure, indirect experiences of others, emotional state, and verbal persuasion. Conversely, volitional self-efficacy may decline due to mistakes of the dieters. This study places volitional self-efficacy at the end in a causal model. Planning and self-regulation continuously provide successful experiences for volitional self-efficacy, and they keep volitional self-efficacy in the level of action maintenance to achieve the purpose of weight loss.

### The interventional foundation of the recursive model

Once the weight-loss plan begins, people, regardless of body conditions, face similar difficulties influenced by the same three psychological factors. The present study takes intervention as the standpoint, and then considers all these factors for this intervention. This is the foundation to describe the action mechanism of the volition stage. According to the HAPA model, the volitional process of weight-loss is regarded as a self-regulation process, and both action and coping planning are considered self-regulating strategies [38]. In effect, an assumption must be acknowledged that an individual can successfully carry out the plan as long as the plan is made. However, in reality, various plans are made but cannot be implemented. From the interventional perspective, the present study found the sequence of each psychological factor influencing the final effect of weight-loss. Furthermore, it is found that better planning, through promoting self-regulation, can enhance volitional self-efficacy, which eventually leads to greater weight-loss. The present study also tested the applicability across people with different body conditions.

It is worth to notice that Chinese female students have shown increased weight loss behaviors in recent years. Liu, et.al. [39] examined the body mass index (BMI) changes among Chinese college students. They found that in a four-year period, the BMI of the participants, over 80% of them were females, decreased significantly when the weights for people in western countries were increasing in general during the same time period. Zhang, Qian, and Fu [40] reported that close to 60% of the participants wanted to be thinner while 30.55% participants in their study were already underweight. Cautious are needed when interpreting or applying or generalizing the findings of this study. Participants in the current study had a BMI greater than 24, indicating obesity or overweight according to the standards defined by the World Health Organization [30]. Reducing weights for these participants would help them become healthier. On another hand, weight-loss for individuals who were not overweight is not healthy and it will not be a good practice.

## Conclusion

Based on the HAPA model, the present study proposed a path model which is intended to account for the psychological mechanism of the weight-loss by Chinese female college students. The model was tested with pervasive applicability across populations with diverse body index (overweight and obese) during different individual sub-phases (intention stage and action stage). Through exploring the interrelationships among planning, self-regulation, and volitional self-efficacy, the study showed that planning could influence weight-loss action through the promotion of self-regulation and self-efficacy. With the crucial roles of controlling and sustaining actions, self-regulation and self-efficacy bridge intention and action. The study also gained a deeper understanding of the mediating role that self-regulation and self-efficacy play between intention and action. The importance of cognitive efforts during the volitional stage in weight-loss action was confirmed.

This study showed the psychological mechanism involved in the volitional phase of weight-loss action. When an individual's motivation to lose weight is formed, an intention is transformed into a volitional phase which involves a series of planning questions, such as, what food to buy/consume, what time to eat, how much to eat, etc. A weight-loss plan needs to consider and identify potential obstacles to the process of losing weight. The more prepared the participant is when planning, the more likely the participant will be able to self-regulate during the process [41]. Likewise, the coping plan uses classical cognitive behavioral therapy to help individuals practice methods before implementing them to improve their ability to respond to obstacles [42]. A coping plan assumes that individuals have practice in self-regulation and are flexible in using coping plans in different situations. Therefore, response strategies to deal with difficult situations are generally consistent with the self-regulation techniques, such as emotional control and self-directed motivation descriptions. These strategies can help improve regulation in response to different situations [43].

Once the weight-loss plan begins, self-regulation is needed to inhibit and resist temptations. Resistance has both a behavioral aspect (e.g. avoid exquisite cakes sold at the roadside) and an emotional aspect (e.g. the excitement of controlling the desire for delicious food). Individuals with high levels of self-regulation will be able to work through potential barriers and accomplish their weight-loss goal [44]. The individual needs metacognitive monitoring to prevent other behavioral tendencies that could interfere with weight loss. Self-regulation also proves to be effective because the whole process and maintenance of weight-loss are similar to delayed gratification.

In the meantime, individuals also need to have self-efficacy, which can determine the individual's level of effort and perseverance in participating in weight-loss activities. High self-efficacy can also

help individuals persevere during difficult times in the weight-loss process. Rather than being influenced by the expectation, the volition phase is more likely to be influenced by volitional self-efficacy, because one's confidence and experience determine both the quality and quantity of her/his planning. The HAPA model assumes that an individual has either a high or low level of self-efficacy, and this level will not change with an individual's successes or failures, but it can be improved through successes and failures, indirect experiences of others, emotional state, and verbal persuasion. Conversely, self-efficacy may decline due to mistakes of, in this case, the dieters. This study places self-efficacy at the end in a causal model. Planning and self-regulation continuously provide successful experiences to improve self-efficacy. They keep self-efficacy in the action maintenance level, to achieve the purpose of weight loss. The findings of current study also support the above discussions.

**Competing interest:** All authors declare that there is no conflict of interest.

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