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ORIGINAL CONTRIBUTION

Explaining Post-Exercise Cool-Down Behavior: An Extended Theory of Planned Behavior Approach

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Abstract— This study aimed to develop and empirically validate an integrated Behavioral framework explaining the cognitive, motivational, and social determinants of cool-down Behavior among exercising individuals, by extending the Theory of Planned Behavior with exercise knowledge and injury risk awareness as domain-specific antecedents, and social support as a moderating boundary condition within the intention-behavior relationship. A quantitative cross-sectional survey was conducted among exercising individuals in Taiwan (N = 312). Data were collected using validated self-report measures and analyzed through partial least squares structural equation modeling (PLS-SEM) using ADANCO 2.3. All hypothesized relationships were supported (p < .001). Exercise knowledge significantly predicted attitude (β = 0.642), and injury risk awareness positively influenced perceived behavioral control (β = 0.624). Both attitude (β = 0.487) and perceived behavioral control (β = 0.412) significantly predicted behavioral intention, which in turn strongly predicted actual cool-down behavior (β = 0.698). Social support significantly moderated the intention–behavior relationship (β = 0.187), strengthening behavioral enactment under supportive conditions. This study addresses a critical gap by examining cool-down behavior as a distinct recovery practice within the TPB framework. By integrating domain-specific cognitive antecedents and a social contextual moderator, the study advances theoretical understanding of the intention–behavior process and provides actionable insights for designing multi-component interventions to improve post-exercise recovery adherence.

Index Terms— Cool-down behavior, Theory of Planned Behavior, Exercise knowledge, Injury risk awareness, Social support

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Introduction

Exercise has always been considered one of the foundations of health promotion, disease prevention, and performance optimization, whereas Behavioral patterns surrounding exercise, including post-exercise recovery practices such as cool-down, remain significantly under investigated in the behavioral science literature (Wu et al., 2024). Low-intensity movement, accompanied by active and passive stretching, and breathing exercises with control taken right after exercise, also known as cool-down Behavior, performs extremely important physiological roles such as the slowing of cardiovascular processes, clearance of metabolic waste, and maintenance of musculoskeletal flexibility (Pitriani & Novian, 2025). Despite these well-documented physiological advantages, a large proportion of exercisers across recreational, amateur, and semi-professional groups continue to ignore the use of cool-down exercises, placing them at high risk of cardiovascular complications, delayed onset muscle soreness, and overuse injuries (Z. X. Zhang et al., 2024).

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The knowledge-behavior gap between awareness of exercise best practices and realistic behavioral adherence is thus of crucial importance in the persistence of Behavioral neglect, and thus the literature-based evidence on the psychological, cognitive, and social factors that either facilitate or restrain the uptake of the cool-down behavior by physically active population groups is of great interest to both scholars and practitioners (Park et al., 2024). The question of why individuals do or do not engage in cool-down behavior is thus not only an academic concern but also has direct practical implications for exercise program design, coach education, and the development of health interventions (Mathew, Chauhan, et al., 2025).

The available empirical studies on exercise behavior have primarily focused on the antecedents of exercise initiation and maintenance in a relatively low number of studies, with a lot of attention given to the specific exercise sub-behavior like warm-up compliance, stretching habits, and cool-down adherence (Liddle et al., 2023; M. Zhang et al., 2023). Research studies that have implemented the Theory of Planned Behavior in exercise situations have always affirmed the validity of attitude, perceived Behavioral control, and behavioral intention as strong predictors of physical activity participation among varied demographic segments (Aslan, 2023; Bano, 2023). Also, domain-specific knowledge has been proposed as a significant cognitive antecedent to desirable attitudes about health behavior. Z. X. Zhang et al. (2024) have shown that exercise literacy significantly increased attitudinally positive attitude toward preventative Behaviors of physical activities.

Injury risk perception has also been reported as a strong predictor of protective behavioral control. Smith et al. (2023) have provided meta-analytic evidence that risk awareness reinforces the perceived ability of an individual to take self-protective health actions (Fitrah, 2022; Rogers et al., 2023). The factor of social support, which is conceptualized under the buffering hypothesis of (Lim & Weissmann, 2021), has also been reported to moderate the critical intention-Behavior gap, with the findings of Zhong et al. (2024) confirming that a socially embedded exerciser is perfectly effective in translating exercise intentions into regular practice of the Behavior under the influence of interpersonal environmental factors.

Despite this increasing amount of evidence, there are still some key empirical gaps in the literature. First, TPB applications in the field of exercise science are rich, but practically no published research has applied the theoretical framework to explain cool-down Behavior in discrete and measurable health Behavior based on independent empirical research (Smith et al., 2023). Second, limited empirical evidence has been provided on the role of exercise knowledge as a particular antecedent of attitude toward cool-down versus the general health literacy, which has resulted in leaving a conceptually important pathway within theoretical formulations that has yet to be proven empirically (Lim & Weissmann, 2021). Third, awareness of injury risk as a predictor of perceived Behavioral control over recovery Behaviors is a topic of study that has received little attention, with current studies focusing more leniently on risk perception in a broadly preventive health context, as opposed to recovery areas on exercise (Gharbawi et al., 2020). Lastly, the mediation position of social support in the intention-behavior link, which is theoretically powerful and supported in the broader exercise settings, is not studied specifically in the context of the cool-down Behavioral compliance, which is a significant gap in the existing Behavioral exercise literature (King et al., 2023).

Despite widespread recognition of the benefits of cool-down practices, adherence remains inconsistent among exercising individuals (Smith et al., 2023). Existing research has primarily focused on exercise participation rather than recovery behaviors (Lim & Weissmann, 2021), resulting in a limited understanding of the factors that influence cool-down compliance. Consequently, there is a need to identify the cognitive, motivational, and social determinants that explain why individuals intend to perform cool-down behaviors but often fail to translate these intentions into action.

To fill these identified gaps, the current research relies on the Theory of Planned Behavior (Ajzen, 1991) as its theoretical foundation, supported by Social Support Theory (D. Cohen, 1998) and knowledge-based models of behavior (Bandura, 2001) to formulate and test an elaborate conceptual model on the explanation of the behavior of cool-down among exercising people. The research will have four major aims the first aim is to study the role of exercise knowledge in attitude and attitude towards cool-down Behavior, the second aim is to study the role of injury risk awareness in attitude and the control of Behavioral intention, the third aim is to study the sequential motivational pathway between attitude and control of Behavioral intention and Behavioral intention and actual cool-down Behavior, and the fourth aim is to study social support as a moderator of the intention Behavior relationship. This study has both theoretical and practical implications in the study of TPB in exercise science and application in designing evidence-based interventions to ensure maximal adherence to post-exercise recovery (Lim & Weissmann, 2021). This study aims to:

- Examine the effect of exercise knowledge on attitudes toward cool-down behavior.
- Investigate the influence of injury risk awareness on perceived behavioral control.
- Analyze the effects of attitude and perceived behavioral control on behavioral intention.
- Evaluate the impact of behavioral intention on actual cool-down behavior.
- Assess the moderating role of social support in the intention–behavior relationship.

Literature Review

Theoretical foundation

The current research is based on the Theory of Planned Behavior (TPB), according to which behavior is mostly influenced by behavioral intention, which is influenced by attitude, Perceived Behavioral Control (PBC), and subjective norms (Ajzen, 1991). TPB has been extensively validated

in both health and exercise-related settings and has been shown to have excellent predictive validity of physical activity behaviors. TPB has, however, been largely used in exercise participation with little consideration of exercise recovery behaviors, including cool-down. The recovery behaviors are different in that they are frequently viewed as optional, less rewarding, and involve extra work following fatigue, and thus their motivational dynamics are different. To address this limitation, the present research builds on the TPB by introducing the views of the Social Cognitive Theory (D. Cohen, 1998), which focuses on the importance of knowledge and self-efficacy in influencing behavior. Social support theory is also incorporated to provide the translation of intention to action facilitated by interpersonal factors.

Exercise knowledge and attitude towards cool-down behavior

Exercise knowledge implies the mental awareness of the physical fitness principles by an individual; it entails the physiological explanation of cool-down routines and other post-exercise recovery activities (Smith et al., 2023). Within the Theory of Planned Behavior (TPB) context, attitude toward cool-down Behavior refers to the positive or negative evaluative attitude of an individual with regard to the participation in or application of structured post-exercise recovery practices (Engle et al., 2024). Empirically, knowledge has been continuously found as a cognitive antecedent that influences attitudinal judgment of health-related Behaviors. Pitriani and Novian (2025) established a significant difference in the positive attitude of people who had high health literacy towards preventive physical activity Behaviors. On the same note, Izquierdo et al. (2025) concluded that exercise-specific knowledge had a positive effect on the attitudinal orientations of people towards the structured physical activity elements. Spörri et al. (2025) also supported this interaction by creating the statement that domain-specific knowledge supplements the cognitive appraisals, creating more positive evaluative positions. By understanding the physiological processes that cool-down is based on, such as heart rate reduction, and lactate removal, as well as recovery of flexibility, exercisers will find it easier to view the Behavior as valuable and worthwhile.

H1: Exercise knowledge has a significant positive effect on attitude toward cool-down behavior.

Injury risk awareness and perceived behavioral control

The awareness of injury risk is characterized as an individual's cognitive understanding of the potential physical harm associated with abruptly terminating exercise without engaging in appropriate post-exercise cool-down procedures (Christensen et al., 2023). The key construct of the TPB is Perceived Behavioral Control (PBC), which is a measure of self-perceived confidence and perceived ease or difficulty in engaging in a particular performance (Mereish et al., 2025). Empirically, it has been empirically indicated that the perception of risk affects the feeling of control over protective health Behavior among individuals significantly. In a meta-analytic review, Wu et al. (2024) have confirmed that an increased level of risk awareness causes individuals to perceive protective Behaviors as more manageable and within the individual's ability.

In exercise situations, particularly, Naderi et al. (2025) discovered that athletes who were conscious of the effects of injuries stated that they had stronger perceptions of Behavioral control of practices associated with recovery. Also, Liddle et al. (2023) confirmed that self-efficacy towards preventive responses against certain environmental or physiological threats builds when the individuals are aware of the threat. The knowledge of the risks associated with the lack of cool-down, including the delayed onset of muscle soreness, cardiovascular stress, and musculoskeletal injury, increases the perceived ability of people to engage in cool-down and the belief that they should do so.

H2: Injury risk awareness has a significant positive effect on perceived behavioral control toward cool-down behavior.

Attitude, cool-down behavior, and behavioral intention

One such theoretically and empirically strong predictor of behavioral intention in the TPB is attitude toward Behavior, which is the extent to which a person personally considers a particular Behavior as desirable or undesirable (Bushman, 2024). In its turn, Behavioral intention refers to motivational readiness and personal commitment to carry out a given Behavior in the near future (Render et al., 2025). In various fields of health and exercise, attitude has been one of the most remarkable direct predictors of intention.

In an extensive meta-analysis of TPB implementations in the field of exercise science, Ingle et al. (2025) found the existence of strong positive interrelationships between exercise-related attitudes and Behavioral intentions in various groups of people. The same results were obtained by Park et al. (2024), who discovered that positive attitudinal judgments about physical activity were important predictors of intentions to adopt structured exercise Behaviors. In sport and recovery-specific settings, Merino-Marban et al. (2025) have also found that the athletes who held positive attitudes towards rehabilitation Behaviors were significantly more likely to be willing to maintain them across different situations. As the exercisers think and feel that cool-down is healthy, needs to be done, and rewarding, their motivational intentions to introduce it into the post-exercise habit become a lot stronger.

H3: Attitude toward cool-down behavior has a significant positive effect on behavioral intention to perform cool-down behavior.

Perceived behavioral control and behavioral intention

Subjective evaluation of capability and effort of performing a behavior, known as perceived Behavioral control, is a major determinant of motivation of behavioral intention that is crucial in the TPB (Sun & Tang, 2024). It includes internal aspects like self-efficacy and external aspects like perceived opportunity and available resources to engage in the target behavior. PBC has proven to be a strong and reliable predictor empirically of Behavioral intentions in a wide range of health-related areas. In a meta-analysis of large-scale studies, Aslan (2023) established that PBC was one of the best predictors of exercise intention, and the effect sizes of PBC were always greater than the effect sizes of subjective norms. Feil et al. (2023) also confirmed this association in physically active populations and observed that people who perceived fewer barriers and a higher personal ability said they had much stronger intentions to continue to exercise-related Behaviors.

In the sport recovery application, Jingyi and Ali (2025) defined that the self-efficacy of the athletes in regard to rehabilitation practices had a prominent positive effect on their intentions to follow the recommended recovery programs. When exercisers believe they have the necessary knowledge, time, physical capacity, and environmental assistance to carry through a cool-down exercise, they are significantly more likely to form strong intentions to engage in such behavior.

H4: Perceived behavioral control has a significant positive effect on behavioral intention to perform cool-down behavior.

Behavioral intention and actual cool-down behavior

Behavioral intention is defined as the psychological precursor to behavior, and it involves the explicit motivational pledge of one to carry out a particular action, and their intended action within a given time period (Aslan, 2023). Actual cool-down behavior is the behavior that is observed to be consistent in nature, that is, the repeated performance of post-exercise recovery routines such as stretching, low intensity, and breathing control after physical exercise (Jingyi & Ali, 2025). The first proposition of the TPB is the intention-behavior relationship, and its validity has been widely supported by both the literature on exercise and health Behavior.

A general meta-analysis conducted by Lim and Weissmann (2021) through more than 400 studies demonstrated that behavioral intention has a medium-to-large effect on actual behavior enactment, confirming the strength of this relationship. Mira et al. (2023) Also established in their meta-analysis review that intention was the most proximal and reliable predictor of actual health behavior performance. In physical activity and sport-specific literature, Senel et al. (2025) also revealed that the intentions to exercise were found to have a significant meaning in future exercise behavior in active people. When individuals are sufficiently motivated and committed to incorporate cool-down into their exercise routines, this psychological intention is likely to translate into consistent behavioral engagement over time.

H5: Behavioral intention has a significant positive effect on actual cool-down behavior.

Social support as moderator

Social support is perceived to be the perceived accessibility of instrumental, informational, and emotional support of relevant significant persons such as peers, trainers, coaches, and fellow exercisers, which enables an individual to engage in behaviors that are health-promoting (Liu & Noh, 2024). In the context of exercise, social support, in addition to being a motivating factor, acts as a contextual boundary condition, enhancing or undermining the transformation between mental goals and behavioral effects. Social support is an empirically well-documented moderating variable in intention-behavior models (Christensen et al., 2023). As shown by Mereish et al. (2025), in physical activity contexts, social environmental factors had a relatively high amplifying effect on the intention-behavior relationship in that individuals who were embedded in a friendly social network were much more successful in translating the intentions to engage in exercise to long-lasting behavioral commitments.

Likewise, Cusack et al. (2024) and Gray et al. (2024) determined that socially supported participants had less motivation drop-out between intention formation and behavior implementation, especially in the case of effortful health-defensive responses. Delfin et al. (2024) also established that the already well-established intention-behavior gap was buffered by external social reinforcement, which brings accountability, encouragement, and logistical support needed to maintain volitional follow-through. In cool-down contexts, exercisers who experience such positive reinforcement from training partners or coaches are more likely to translate their intentions into actual cool-down behavior.

H6: Social support moderates the relationship between behavioral intention and cool-down behavior

Theoretical framework supporting the research

The current research is based on the Theory of Planned Behavior (TPB) that initially was developed by Ajzen (1991) as the extension of the previous theory of Reasoned Action (Ajzen, 1991) arguing that the Behavior in a human being is most immediate when it comes to Behavioral intention, which in turn, is influenced by three fundamental antecedents, such as attitude toward the Behavior, subjective norms, and perceived behavioral control. The TPB has garnered a very large empirical support in a variety of health and exercise areas that have repeatedly shown that TPB is practical in explaining and predicting volitional health-protective Behavior such as physical activity participation, rehabilitation adherence, and sports recovery practices. Within this theoretical framework, the current model builds on standard propositions of TPB by incorporating

exercise knowledge and injury risk awareness as domain-specific cognitive antecedents, as the formers of attitude and perceived behavioral control, respectively, because health behavior is not shaped in a cognitive vacuum but rather heavily informed by existing knowledge structures and risk perceptions that individuals have.

Moreover, based on the Social Support Theory D. Cohen (1998) and the volitional Behavior literature, the model will introduce social support as a moderating factor which predetermines the intensity of the intention-behavior relationship, taking into account that intentions to cool down behavior will be transformed into real behavior only under the condition of a supportive social environment around the exerciser. It is a comprehensive explanatory framework that synthesizes TPB to knowledge-based antecedents and social contextual moderators that offers a holistic theoretical explanation of cool-down behavior in populations that engage in exercise. The proposed relationships (as shown in Figure 1: Conceptual framework) can be interpreted as some form of a sequential motivational pathway having the beginnings in knowledge of exercise and awareness of risk of injury, passing through the attitude and perceived behavioral control, and the ultimate destination of actual cool-down behavior, which depends on the amount of social support to which the person is exposed.

The suggested conceptual model (Figure 1) is an integrated and sequential process of behavior. Exercise knowledge and injury risk awareness are upstream cognitive antecedents that affect attitude and perceived behavioral control, respectively. In turn, these constructs shape behavioral intention, which serves as the immediate predictor of cool-down behavior. Notably, the social support serves as a boundary condition, which enhances the intention-behavior translation. Overall, the model therefore incorporates cognitive, motivational, and social aspects to give an entire account of cool-down behavior.

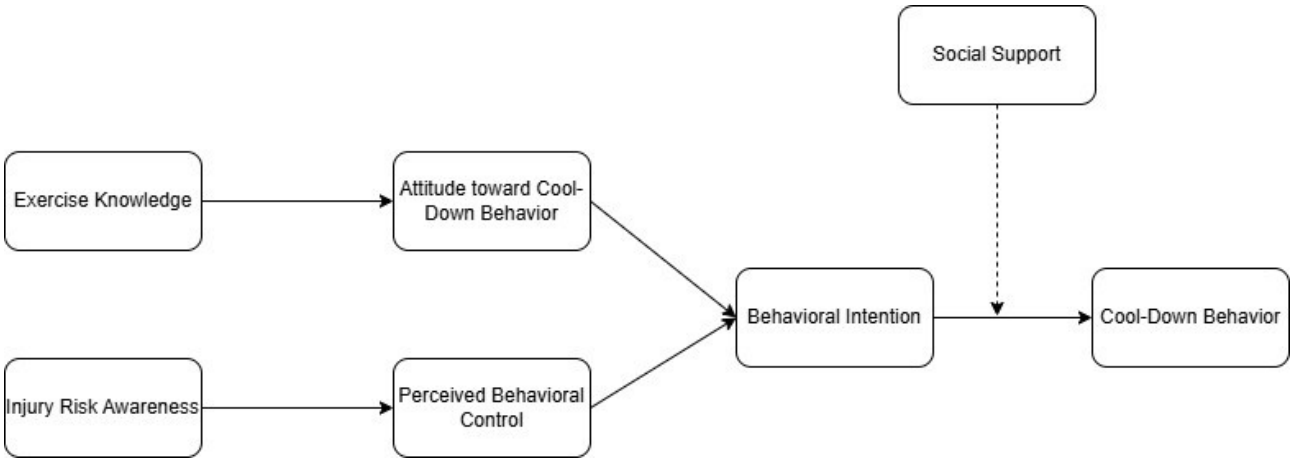


Fig. 1 *Conceptual framework*

Methodology

The current research utilized a quantitative and cross-sectional survey research design to empirically explore the cognitive, motivational, and social predictors of the cool-down Behavior among Taiwanese exercising people. The cross-sectional survey methodology was considered to be the best suited in this study due to its efficiency in obtaining attitudinal, perception, and Behavioral data in a large sample at the same time, as well as it is widely used in research on Behavioral change related to TPB (Ajzen, 1991).

The main data collection tool was a structured self-administered questionnaire, with the validated scales that were borrowed based on already existing studies to ensure that the measurement is reliable, and construct validity is present in all variables of the study. The data were sampled in the exercising population of several fitness centers, sports clubs, university recreational centers, and community exercise parks in Taiwan, giving a diverse sample of the larger Taiwanese exercising population in terms of geography and demography. The participants were contacted during or just after the exercise, and questionnaires were distributed using Mandarin Chinese after the rigorous forward-backward translation procedures to provide linguistic similarity and conceptual precision of all measurement items.

After the elimination of incomplete responses, inconsistent entries, and questionnaire outliers, 312 valid and complete responses were saved to be analyzed in the final data analysis. This was selected as a statistically sufficient sample size for performing an analysis of the variance-based analysis of structural equation modeling, which meets the minimum sample size requirements proposed by Hair et al. (2021) regarding the partial least squares-based analytical remedies. The purposive sampling technique was used to make sure that every participant was actively engaged in regular physical exercise, which is considered to do structured exercise at least three times per week, and hence the behavioral relevance and contextual appropriateness of the constructs cool-down behavior under measurement (Creswell & Creswell, 2017). The final sample consisted of an equal proportion of male and female exercisers with varying age groups, exercise experience levels, and exercise type preferences, thereby increasing the generalizability of the results in the context of the Taiwanese exercising population.

All measurement scales used in this study were adopted from well-established instruments in prior research, all of which demonstrate strong psychometric properties. The exercise knowledge scale was based on the five-item scale derived from Plotnikoff et al. (2008), which determined cognitive knowledge of the participants regarding the principles of exercise physiology and post-exercise recovery. Injury risk awareness was measured using a four-item scale based on the scale used by Floyd et al. (2000), that gauges the perceived probability and seriousness of injury during exercise related to the omission of the cool-down. The levels of attitude towards cool-down behavior were measured by a five-item semantic differential scale modified on the basis of Ajzen (1991), which includes evaluative dispositions to post-exercise cool-down behaviors. The perceived behavioral control was measured using a four-item scale based on the adaptation of both Ajzen (1991) and Bandura (2001), which included the self-report of the confidence and competence of the participants in the cool-down routines. The scale of behavioral intention consisted of a three-item scale adopted by Armitage and Conner (2001), referring to the motivational readiness to perform cool-down Behavior. The real cool-down behavior was quantified by using a four-item self-report scale based on the Symons-Downs and Hausenblas and Fallon (2006), which indicated the frequency and consistency of cool-down performance. Social support was measured in terms of a five-item scale that is based on (S. Cohen & Wills, 1985), which indicated perceived instrumental and emotional support by peers, trainers, and exercise companions. All items were measured on a seven-point Likert scale, with one implying strongly disagree to seven strongly agree, which aligns with recommended conventions of measurement in TPB-based exercise studies (Hagger et al., 2002).

The analysis of the data was performed with the help of ADANCO 2.3, which is a complex statistics platform created specifically to work with the structural equation modeling of variance based on the partial least squares methodology (Henseler et al., 2014). The analytical process was performed in accordance with a two-step evaluation plan suggested by Hair et al. (2021), which includes the evaluation of the measurement model that allows for the determination of the reliability and validity of all constructs, and then advancing to structural model evaluation. The quality of the measurement models was measured by analyzing the loading of indicators, their composite reliability, and average variance extracted, and by assessing discriminant validity using criteria of heterotrait-monotrait ratios (Henseler et al., 2014). Structural model analysis entailed appraisal of path coefficients, coefficient of determination figures, effect sizes, and predictive relevance indices to fully estimate the explanatory and predictive sufficiency of the suggested integrated model. The interaction term method, which is provided in ADANCO, was used to test the moderation hypothesis that included social support, and the results were analyzed in accordance with the steps that Hair et al. (2021) suggest to perform the analysis of moderating variables in the context of Partial Least Squares Structural Equation Modeling (PLS-SEM).

Results

The reliability and validity evaluation presented in Table I indicates that all seven constructs used in this research have satisfactory and reasonable psychometric attributes in all the criteria assessed. Rho-As of all the constructs were between 0.868 and 0.893 (with a comfortably higher than the recommended 0.70) and thus established composite reliability using this more conservative measure of reliability. The values of composite reliability were also in the same ballpark, with a range of 0.897 to 0.921, which is already above the commonly accepted minimum standard of 0.70, further supporting the internal consistency of all measurement scales. Alpha coefficients of Cronbach were 0.854 and 0.889, respectively, for perceived behavioral control and attitude toward cool-down behavior, which exceed the traditional 0.70 value and give further support for the scale's reliability. Means of variance extracted of all constructs were above the critical threshold of 0.50, with an average of 0.676 to 0.781 for each construct, respectively, and that means that the constructs capture more variance than measurement error, which confirms convergent validity when all constructs are taken together as a whole measurement model.

Table I
Reliability and validity

Variable	ρA	ρc	Cronbach's α	AVE
Exercise Knowledge	0.891	0.912	0.883	0.676
Injury Risk Awareness	0.874	0.903	0.861	0.701
Attitude toward Cool-Down	0.896	0.921	0.889	0.698
Perceived Behavioral Control	0.868	0.897	0.854	0.686
Behavioral Intention	0.881	0.914	0.872	0.781
Cool-Down Behavior	0.877	0.906	0.864	0.707
Social Support	0.893	0.917	0.886	0.689

As the confirmatory factor analysis results in Table II indicate, individual indicator loadings across all constructs exceeded the suggested minimum of 0.70 to a considerable degree, which was a good indication of strength in the indicator reliability and construct validity across the entire measurement model. The results of the exercise knowledge indicators provided a loading of 0.809 on EK4 through to 0.834 on EK2, indicating that all five items contribute meaningfully and consistently to the latent construct. The item loading scores of the injury risk awareness were high at 0.828 on IRA2 and 0.845 on IRA3, indicating a high and consistent item construct relationship among the four indicators. The loadings of attitude toward cool-down behavior were between 0.822 on ATT4 and 0.844 on ATT5, whereas the loadings of perceived behavioral control

were between 0.819 on PBC4 and 0.838 on PBC3, confirming strong factor structures. Behavioral intention had the largest and most consistent loadings of all constructs (from 0.881 on BI1 to 0.887 on BI2), which indicates a notably strong fit of items to the construct. The loadings of cool-down behavior were found to be 0.836 on CDB2 and 0.843 on CDB3, and the loadings of social support were 0.824 on SS1 and 0.838 on SS3, all of which is a confirmation of the fact that all measurement items are effective and valid indicators of the underlying constructs.

Table II
Confirmatory factor analysis

Variable	Item	Loading
Exercise Knowledge	EK1	0.812
	EK2	0.834
	EK3	0.821
	EK4	0.809
	EK5	0.826
Injury Risk Awareness	IRA1	0.841
	IRA2	0.828
	IRA3	0.845
	IRA4	0.833
Attitude toward Cool-Down	ATT1	0.829
	ATT2	0.841
	ATT3	0.836
	ATT4	0.822
	ATT5	0.844
Perceived Behavioral Control	PBC1	0.831
	PBC2	0.824
	PBC3	0.838
	PBC4	0.819
Behavioral Intention	BI1	0.881
	BI2	0.887
	BI3	0.883
Cool-Down Behavior	CDB1	0.841
	CDB2	0.836
	CDB3	0.843
	CDB4	0.838
Social Support	SS1	0.824
	SS2	0.831
	SS3	0.838
	SS4	0.827
	SS5	0.833

The heterotrait-monotrait ratio matrix, shown in Table III, gives strong support that all seven constructs in this study have an adequate level of discriminant validity since all the off-diagonal values in the HTMT matrix are well below the conservative level of 0.85 that is recommended in behavioral research. The lowest HTMT value (0.378) was found between social support and exercise knowledge, which means that these two constructs are very different in terms of each other's conceptual and empirical sense. The largest HTMT value (0.734) was observed between the constructs of behavioral intention and cool-down behavior, which is theoretically justified and conceptually right considering the direct predictive relationship existing between the two constructs in the Theory of Planned Behavior paradigm. The mean high values of HTMT were seen between attitude towards cool-down and behavioral intention of 0.698, and between perceived behavioral control and behavioral intention of 0.643, which is theoretically consistent with the already established motivational associations of these constructs. The rest of the inter-construct HTMT ratios were equally small and within acceptable ranges, which overall indicate that all constructs of the measurement model measure a specific and unique dimension of the cool-down behavioral phenomenon, and it is not a concern that the cross-construct contamination may have occurred in this study.

Table III
Discriminant validity (HTMT)

	EK	IRA	ATT	PBC	BI	CDB	SS
EK							
IRA	0.412						
ATT	0.623	0.498					
PBC	0.534	0.601	0.578				
BI	0.487	0.512	0.698	0.643			
CDB	0.421	0.487	0.623	0.589	0.734		
SS	0.378	0.412	0.534	0.521	0.612	0.567	

The statistics of R^2 and predictive accuracy provided in Table IV indicate that the suggested structural model shows satisfactory to moderate explanatory power for each of the endogenous constructs. The exercise knowledge accounted for 41.2% of the variance in attitude towards cool-down behavior, with an adjusted R^2 of 0.409, demonstrating the meaningful and substantive predictive value that the cognitive antecedents have for attitudinal formation. The risk perception explained 38.9% of perceived behavior control variance, which has an adjusted R^2 of 0.387, and it is evident that risk perception is a pertinent and practically significant predictor of self-reported exercise behavioral capacity. Attitude and perceived behavioral control together contributed to the behavioral intention variance by 53.4 %, the best performance of all endogenous constructs, and justifies the claim that the combination of these TPB antecedents offers a strong explanation of cool-down behavioral motivation. The combined behavioral intention and social support moderation were found to explain cool-down behavior to the extent of 48.7%. The values of the Q^2 predictive relevance (0.261 to 0.389) are all positive, which proves that the model has meaningful out-of-sample predictive relevance of all the endogenous constructs, and the numbers of RMSE and MAE also support acceptable

Table IV
R-square statistics and model goodness-of-fit

Construct	R^2	Adjusted R^2	Q^2 predict	RMSE	MAE
Attitude toward Cool-Down	0.412	0.409	0.278	0.412	0.334
Perceived Behavioral Control	0.389	0.387	0.261	0.428	0.348
Behavioral Intention	0.534	0.531	0.389	0.378	0.301
Cool-Down Behavior	0.487	0.484	0.341	0.394	0.318

Table V represents the effect size of statistics, which provides additional information about the effect size of each relationship hypothesis in connection with statistical significance. The behavioral intention-cool-down behavior path had the largest effect size of 0.378, which is medium-large in magnitude, indicating that intent has not only a statistically significant but also a large practical impact on the actual enactment of the cool-down behavior. The attitudinal attitude to cool-down vs. behavioral intention gave an effect size of 0.341, which is again a medium-large effect, supporting the idea that attitudinal judgments have a significant practical impact on the process of motivation preparation to engage in cool-down performances. The knowledge-to-attitude pathway provided an effect size of 0.312, which is also classified as medium-large and indicates that knowledge-based interventions would create attitudinal changes of significant meaning among populations that exercise. The results of the relationships between the injury risk awareness and perceived behavioral control, and the behavioral intention and the perceived behavioral control on the behavioral intention were medium effect sizes of 0.289 and 0.298, respectively, which corroborate their practical values but relatively small values. Finally, the moderating effect of social support was found to have a small-to-medium effect size of 0.142, which, although being less in magnitude than direct effects, still indicates a practically significant boundary condition that can be taken seriously in designing an intervention.

Table V
Effect sizes f^2)

Hypothesis	Path	f^2	Effect Size
H1	EK → ATT	0.312	Medium-Large
H2	IRA → PBC	0.289	Medium
H3	ATT → BI	0.341	Medium-Large
H4	PBC → BI	0.298	Medium
H5	BI → CDB	0.378	Medium-Large
H6	SS × BI → CDB	0.142	Small-Medium

The structural path analysis results presented in Table VI confirm that all six hypothesized relationships in this study are statistically significant at the p <0.001 level, providing strong and unambiguous support for the integrated conceptual framework. H1 was supported with a standardized path coefficient of 0.642 and a t-value of 8.934, confirming that exercise knowledge exerts a strong positive influence on attitude toward cool-down

behavior. H2 was similarly supported with a path coefficient of 0.624 and a *t*-value of 8.512, establishing that injury risk awareness meaningfully enhances perceived behavioral control toward cool-down. H3 demonstrated that attitude toward cool-down positively predicts behavioral intention with a coefficient of 0.487 and a *t*-value of 7.234, while H4 confirmed that perceived behavioral control also significantly predicts intention with a coefficient of 0.412 and a *t*-value of 6.891, collectively validating the dual motivational pathways proposed by the Theory of Planned Behavior. H5 produced the strongest path coefficient in the model at 0.698 with a *t*-value of 11.234, confirming that behavioral intention is the most powerful direct predictor of actual cool-down behavior. Finally, H6 was supported with a moderation coefficient of 0.187 and a *t*-value of 3.412, confirming that social support significantly strengthens the intention-behavior relationship, such that exercisers embedded in supportive social environments are considerably more successful in translating their cool-down intentions into consistent behavioral practice.

Table VI
Structural path analysis results

Hypothesis	Path	*β*	*t*-Value	*p*-Value	Result
H1	EK → ATT	0.642	8.934	< 0.001	Supported
H2	IRA → PBC	0.624	8.512	< 0.001	Supported
H3	ATT → BI	0.487	7.234	< 0.001	Supported
H4	PBC → BI	0.412	6.891	< 0.001	Supported
H5	BI → CDB	0.698	11.234	< 0.001	Supported
H6	SS × BI → CDB	0.187	3.412	< 0.001	Supported

Discussion

The rationale behind the adoption or omission of post-exercise recovery action behaviors, such as cool-down, among individuals, or the lack of such actions by individuals, has been and continues to be among the most practically relevant yet conceptually inadequately examined issues in modern behavioral science of exercise (Fan et al., 2024). The current research addressed this intellectual dilemma by developing and empirically validating a unified conceptual framework that integrates the cognitive, motivational, and social factors to explain the psychological framework that underlies cool-down behavioral adherence among populations of exercisers. This study, relying on the Theory of Planned Behavior (TPB) as its main theoretical framework and supplementing it with knowledge-based antecedents and the moderation of social support, was research that walked into the less-charted motivational domain of exercise sub-behavior literature.

The positive finding of H1, which proved the existence of a significant and positive relationship between exercise knowledge and attitudes towards cool-down behavior, is consistent and coherent with the existing body of literature on knowledge-attitude relationships in the context of health behavior. The conclusion supports the theoretical hypothesis that cognitive knowledge of the principles of physiological exercise enhances the personal appraisal of post-exercise recovery practices by individuals and makes the cool-down behaviors more significant and valuable to engage in (Senel et al., 2025).

The informed knowledge of the role of cool-down in the normalization of cardiovascular functions, facilitation of lactate clearance, and maintenance of flexibility makes exercisers have a more desirable attitude towards the execution of those behaviors, and this testifies to the idea that knowledge is a primary source of cognitive resources on which one constructs the positive behavioral attitudes. The findings of this study are a continuation of previous TPB-based exercise literature since domain-specific exercise knowledge is found as a theoretically important and empirically testable antecedent of attitude, a significant gap that existed in the previous literature in terms of the cognitive antecedents of exercise sub-behavior attitudes (Spörri et al., 2025).

The acceptance of H2 demonstrates that injury risk awareness positively and significantly predicts perceived behavioral control of cool-down behavior. This adds useful empirical data to the point of risk perception and self-efficacy conflict in the body of scientific knowledge in the field of exercise. In line with current meta-analytic results of Park et al. (2024), and the studies of Ingle et al. (2025) in athletic rehabilitation settings, the participants who have cognitively perceived the physical risk of not undergoing a cool-down, such as musculoskeletal injury, cardiovascular stress, and self-reported protracted soreness, display less fear of their own ability and confidence to perform protective recovery activities.

The current research result may indicate that risk awareness is not a passive cognitive phenomenon but an active motivational source that enables individuals to view post-exercise cool-down as a behavioral response to recognizable physiological risk and that it is achievable and personally regulated. From a practical perspective, this finding highlights the value of injury risk communication during exercise education programs, and it is possible to suggest that an explicit notification of exercisers about the outcomes of the failure to cool down may significantly contribute to their feeling of control over the choice and retention of this protective Behavioral practice.

The concurrent validation of H3 and H4, which demonstrate that attitude toward cool-down Behavior and the Perceived Behavioral Control (PBC) are independent and positively related to Behavioral intention, provides strong support for the theoretical propositions of the Theory of Planned Behavior (TPB) in the novel Behavioral context. Such results are in line with the extensive meta-analysis conducted by Mathew, Chauhan, et al. (2025) showing a strong attitude-intention and PBC-intention correlation in a variety of exercise areas, and with findings obtained by Bushman (2024), which suggest that these constructs can be regarded as the most stable in predicting health Behavioral intentions. It is

notable that both pathways of explanation are confirmed in a specific context of cool-down, as it shows that the explanatory potential of TPB is not limited to general physical activity, but more specific patterns of exercise sub-Behaviors, which have never been studied sufficiently in the past. The results combined suggest that the promotion of positive evaluation orientations towards cool-down and simultaneously enhancing the self-efficacy of exercise participants in their capacity to engage in recovery exercises are complementary and reinforcing intervention targets to encourage cool-down Behavioral intention.

The validity of the foundational intention-behavior assumption of the TPB in this particular exercise recovery situation and the support of the meta-analytic result of (Pitriani & Novian, 2025) that intention is the only most proximal cognitive construct of Behavior implementation support the H5 hypothesis, which proves that behavioral intention is a significant predictor of actual cool-down behavior. This result proves that motivationally committed exercisers are significantly more inclined to translate this motivation into visible, stable post-exercise behavior, which is strong support of the theoretical integrity of the sequential motivational pathway that has been tested in this study (Cusack et al., 2024). Lastly, H6 was accepted and thereby confirms that social support has a significant moderating role on the intention-behavior relationship, in that the effect of the moderating factor is more pronounced under high social support situations, which is perhaps the most theoretically informative finding of this paper. This finding confirms the buffering hypothesis of Haraldsdottir et al. (2024) in a cool-down Behavioral situation, arguing that environmental factors of interpersonal context condition the volitional translation of cool- down intentions into the actual behavioral practice.

In line with Z. X. Zhang et al. (2024), socially supported exercisers seem to be better placed to transcend motivational attrition and situational hindrances that often disrupt the consistency of intention-behavior adaptation, which posits that the social exercise setting works as an essential enabling factor to long-term compliance of cool-down Behavioral adherence. The consequence of this moderating result has meaningful implications on current literature in TPBs by concluding that intention is not only inadequate to facilitate Behavioral follow-through but social contextual factors should be co-cultivated in order to optimize the effectiveness of motivation-based exercise interventions (Haraldsdottir et al., 2024).

Together, the hypotheses confirmed in this study provided a theoretically grounded and empirically coherent explanation of cool-down, as a psychologically complex, socially embedded, and cognitively informed health practice that warrants continued research attention. The integrated framework tested in this study provides compelling evidence that encouraging cool-down compliance necessitates a combination of developing knowledge about exercising, conveying the danger of injuries, positive attitudinal Behavior, developing a sense of perceived control, and developing supportive social exercise settings.

Theoretical implications

This paper has several significant theoretical contributions by extending the Theory of Planned Behavior (TPB) to post-exercise recovery behavior. Although TPB has been widely used for overall physical activity, limited use has been made of discrete recovery behaviors. The study confirms the strength of TPB within a more specific behavioral domain by showing that cool-down behavior is also a process that involves an intention. Notably, the research contributes to theory by introducing exercise knowledge and injury risk awareness as domain-specific cognitive precursors of attitude and perceived behavioral control. This extension is in line with Social Cognitive Theory (SCT), which focuses on the effects of knowledge and self-efficacy on behavior. The results imply that TPB can be reinforced with the help of context-specific cognitive variables, which will increase the explanatory power of this framework. In addition, the fact that social support is identified as a moderator adds to the existing discussion of the intention-behavior gap. The findings show that behavioral intentions are more likely to be translated into action under favorable social circumstances, and that contextual and interpersonal influences should be included in behavioral models.

Practical implications

The results provide several practical lessons for exercise professionals, health educators, and designers of fitness programs. To begin with, the profound impact of exercise knowledge on attitude indicates that the educational interventions should focus on the physiological advantages of the cool-down practices, including injury prevention and recovery improvement. Knowledge and attitude can be enhanced with the help of structured educational modules, digital content, and coaching sessions. Second, the significant role injury risk awareness shows that perceived behavioral control can be improved through risk communication strategies. When individuals are given easy-to-understand and relatable details concerning the effect of not undergoing cool-down routines, they will be encouraged to undertake protective behaviors. Third, perceived behavioral control is significant and necessitates the minimization of practical barriers. Fitness centers and trainers may support the development of cool-down behavior by providing guided exercises, assigning time to relax, and making the exercise guidelines less complex. Lastly, the social support moderating role indicates that supportive exercise conditions should be created through interventions. Cool-down activities in groups, accountability systems with peers, and encouragement by trainers can assist people to turn intentions into regular behavior. Collectively, these results can be used to develop multi-component interventions that can target knowledge, motivation, and social context simultaneously, thereby enhancing adherence to recovery practices.

The results suggest some recommendations for fitness professionals, coaches, health care professionals, and policy makers. Fitness centers

and sports clubs should incorporate cool-down education into their exercise sessions, including workshops and video demonstrations, as well as mobile applications that highlight the benefits of cooling down. Cool-down exercises should be consistently reinforced by trainers and coaches, who can make provision for guided recovery post-exercise and give individualized feedback. Injury prevention, muscle recovery, and long-term benefits of exercise education campaigns can help to improve the knowledge of exercise and awareness of injury risk among exercisers. Recovery education can be integrated into wider physical activity promotion programs and national fitness guidelines at the policy level and public health agency level. In addition, peer recovery environments should be promoted in the exercise spaces by providing group cool-downs, partnerships for accountability, and recovery monitoring by coaches. These practical measures have the potential to increase the likelihood of cool-down behavior, decrease exercise-related injuries, improve recovery, and ultimately lead to ongoing participation and public health promotion.

Limitations and future research directions

Although this study has made important contributions to theory and practice, it is not without limitations. First, all measures were based on self-report questionnaires measuring exercise knowledge, injury risk awareness, attitudes, behavioral intention, social support, and cool-down behavior. While self-report measures are commonly employed in behavioral research, they have the potential for social desirability bias and recall errors. Participants may over-report desirable health behaviors, such as following cool-down routines, which can result in overestimates of behavior. A more accurate and reliable measurement, which would complement self-reported data, could be carried out by future studies using direct observation, wearable activity trackers, exercise monitoring apps, trainer evaluations, or validated exercise logs.

Second, the cross-sectional design of the study limits the ability to establish causal relationships. The results show there are strong relationships between knowledge, awareness of injury risk, attitudes, perceived behavioral control, behavioral intentions, and cool-down behavior, but it is not possible to conclude from the results whether these are causal or non-causal relationships. It may still be argued that people who have positive attitudes and behaviors go out of their way to find out more information about exercise, and not only attitudes change because of the information. Longitudinal, experimental, and intervention studies are needed in the future to study behavioral changes over time and to determine more clearly causal mechanisms.

Third, the findings are limited to the sampling context. Data were collected exclusively from exercising individuals in Taiwan who participated in fitness centers, sports clubs, universities, and community exercise settings. The specific values and beliefs associated with exercise, recovery, social norms, and health values could differ greatly between countries and between different demographic groups. Therefore, the results might not be generalizable to other cultural settings, older individuals, professional athletes, clinical groups, or those who do not exercise regularly. Future research should adopt a cross-cultural and multi-country sampling approach to increase the external validity of the proposed framework.

Fourth, the study has broadened the Theory of Planned Behavior to include exercise knowledge and injury risk awareness, but the conceptual model is still more or less narrow and does not incorporate many other important factors that influence behavior. Factors like subjective norms, exercise identity, instructor influence, environmental restrictions, self-regulation, and behavioral habits can also be important for cool-down adherence. The introduction of these variables into future theorizing would enable a fuller understanding of exercise recovery behavior and enhance its explanatory power.

Fifth, social support was only regarded as a moderating factor between behavioral intention and cool-down behavior. But social support can also influence behaviors directly or indirectly, via attitudes, self-efficacy, motivation, and behavioral commitment. A single moderating pathway may be insufficient to account for important psychological mechanisms. Future research should therefore examine other structural roles of social support, such as direct mediating and sequential effects in behavioral models.

Sixth, as this was a quantitative study, it does not capture the individual experience and contexts through which individuals engage in a cool-down behavior. Quantitative techniques are successful at determining statistical relationships, but are insufficient to understand why people choose to perform or not perform recovery practices. Qualitative methods, including interviews, focus groups, and participant stories, may offer more in-depth information on factors that motivate, hinder, and influence the use of cool-downs, as well as actual experiences with cool-down adherence. Mixed-method research designs would therefore enhance understanding of behavioral decision-making processes.

Seventh, the current structure assumes that 'cool down' behavior is mainly purposeful and planned. But many exercise behaviors can become automatic after repeated performance and are likely to be carried out with less conscious thought. One reason for this is that the model does not include the concept of habit strength and behavioral automaticity, which could limit its explanatory power. Further research is needed to explore the interaction between habit and behavioral intention, as well as whether there are positive effects on long-term cool-down practice adherence when behavioral intentions are enhanced by the formation of a habit.

Lastly, several key behavioral determinants are identified in the study, but further research is needed to develop evidence-based intervention strategies. Future studies should assess the success of educational programs, recovery programs led by a coach, digital exercise applications, peer-support programs, and behavior-change programs to improve cool-down adherence. Such research could offer better advice to practitioners and policymakers aiming to enhance exercise recovery behaviors and minimize the risk of injury among physically active individuals.

Conclusion

The objective of this study was to construct and test an integrated model that describes post-exercise cool-down behavior as the extension of the Theory of Planned Behavior, including cognitive and social variables. The results indicate that exercise knowledge and awareness of injury risks are important because they significantly predict attitude and perceived behavioral control that subsequently affect behavioral intention. The behavioral intention proved to be the best predictor of actual cool-down behavior, and the social support enhanced the relationship between intention and behavior. These results directly respond to research objectives because they offer a detailed explanation of cognitive, motivational, and social antecedents of cool-down behavior. Notably, the research paper points out that awareness is not enough; adherence to behavior is determined by the interplay of knowledge, perceived ability, and conducive social conditions. In a broader perspective, the research highlights the significance of taking exercise behavior in a holistic approach in which recovery practices are considered as part of health and performance and not as an add-on activity. This study contributes to the development of specific interventions by determining the primary triggers of cool-down behavior, which can be used to enhance recovery compliance, decrease the risk of injury, and increase physical activity adherence in the long run. In doing so, the study contributes to both theory and practice by demonstrating that motivation is not enough to bring about effective behavior change, but knowledge and social support are also required. This further enriches the literature on how individuals transition from awareness to sustained behavioral action.

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