Title	Subjective knowledge in open water activities: Scale development and validation
Author(s)	Heetae Cho, Koon Teck Koh and Lit Khoon Chian

This is the accepted author's manuscript of the following article:

Cho, H., Koh, K. T., & Chian, L. K. (2023). Subjective knowledge in open water activities: Scale development and validation. *International Journal of Sports Science & Coaching*. Advance online publication. https://doi.org/10.1177/17479541231168513

Subjective Knowledge in Open Water Activities: Scale Development and Validation

Heetae Cho[a], Koon Teck Koh[b*] and Lit Khoon Chian[b]

[a] Sungkyunkwan University, South Korea
[b]Nanyang Technological University, Singapore

Published in April 2023

International Journal of Sports Science & Coaching

DOI: 10.1177/17479541231168513

ABSTRACT

Subjective knowledge is a significant factor influencing individuals' behaviors. It plays a critical role in preventing people from a tragic event during open water activities. However, a measurement scale for subjective knowledge in open water activities has not been developed and comprehensively investigated in the field of maritime and coaching studies. Therefore, this study aimed to develop and validate a subjective knowledge scale in open water activities (SKS-OWA) to better understand participants' safety perceptions. We collected data from individuals who participated in open water activities within three years in Singapore. This study conducted the pilot study (n = 260) and the main study (n = 453) and employed a rigorous scale development procedure to assess the psychometric properties of the SKS-OWA. The findings of this study contribute to a better understanding of subjective knowledge in open water activities, and the SKS-OWA can be used to help coaches and practitioners to plan their training programs, increase public awareness, and reduce the rates of deaths from drowning.

Keywords: Subjective knowledge; Open water; Scale development; Water safety; Drowning

INTRODUCTION

Participation in open water activities is generally perceived as a positive indicator of a healthy lifestyle, as it could offer multiple benefits for physical, social, and psychological health, such as increasing social interaction and reducing depression [1-2]. However, there are several potential dangers and consequences that may occur from recreational activities in an open water area such as drowning and injuries. Indeed, drowning is a leading cause of injury-related deaths in many countries [3] including Singapore, where its border is mostly contiguous to the sea or ocean, resulting in easy access to open water sites and active participation in open water activities such as swimming, diving, fishing, sailing, paddling, and snorkeling.

Unfortunately, at least 18 Singaporeans have died in open aquatic environments since 2007 for causes ranging from capsized boats to diving accidents, and four of these cases were located inside the region of Singapore [4]. More recently, a man died from an accident during his fishing trip at Pulau Bukom [5], and a 21-year-old man reportedly drowned after swimming in a canal in Serangoon with a group of friends [6]. As the number of people visiting beaches and pools for both leisure and exercise purposes has increased steadily since the 20th century, more people are at risk of drowning [7]. World Health Organization [8] estimated that 236,000 people lost their lives from drowning in 2019; with a major contributing factor linked to people’s lack of open water knowledge [9].

In various academic fields, researchers have developed several knowledge scales to measure their relationship with various outcome variables, such as the acceptance rate toward green-labeled residential buildings [10], numerical understanding and competency [11], and the effects of alcohol on different individuals [12]. For example, in the context of organizational studies, Shockley et al. [13] developed the subjective career success inventory to measure subjective career success. Flynn and Goldsmith [14] conceptualized consumer knowledge and developed a subjective knowledge scale, which can be employed to test consumer theories. However, while researchers have highlighted the importance of knowledge and developed various knowledge scales in different academic fields, there is no scale to measure how individuals perceive their knowledge of open water activities.

Given that knowledge is a significant antecedent of attitude and behavioral outcomes [15-16], it is critical to understand how individuals, including coaches and practitioners, perceive their knowledge in open water activities to inform practices and avoid unfortunate incidents. Therefore, this study aims to develop a subjective knowledge scale in open water activities (SKS-OWA) to prevent accidents and to better understand participants' safety perception which can influence their behavior change. In addition, we investigated how open water activity participants' knowledge is related to future risky behavior. The findings of this study contributed to the literature in understanding the dimensional structure of subjective knowledge in open water activities, which would be helpful to coaches and practitioners to guide their practices and increase participants' awareness to reduce the rates of deaths from drowning.

SUBJECTIVE KNOWLEDGE

Subject knowledge refers to how individuals perceive their knowledge, and how much they think they know [17-19]. The concept of subjective knowledge has been studied in various contexts and has been shown to influence individuals' psychological and behavioral outcomes. For instance, business research found subjective knowledge about products to be positively associated with commitment to recycling [20]. A positive relationship between subjective knowledge and attitude toward organic food was found in a food consumer study [21]. Jin and Han [22] found that individuals with more subjective knowledge were less affected by how a message is framed.

A study in the consumer behavior context found that, when given more choices for products, people with lower subjective knowledge were more willing to purchase, while people with higher subjective knowledge were less willing to do so [23]. In the context of tourism, Tassiello and Tillotson [24] found that tourists who perceived themselves to have more subjective knowledge of a destination had a weaker intention of traveling to that particular destination because of a sense of familiarity. Kirkpatrick [25] found that individuals with greater subjective knowledge towards scientific research were more likely to share fake news online, especially when they perceived the threat as serious. These studies suggest that the level of subjective knowledge influences the choice individuals make across a wide range of contexts, including sports.

As more and more people take up open water activities to enhance their physical, social and mental health [1-2], and open water sports are high-risk activities, a lack of subject knowledge in this area can lead to danger and life-threatening consequences. Thus, it is important to understand the subject knowledge of people who are involved in open water activities directly (e.g., beachgoers, swimmers, coaches, practitioners, the national federation, and policy maker) or indirectly (e.g., bystanders and the public) to guide coaching education program and practices, as well as maritime policy to prevent unfortunate incidents to save lives.

SUBJECTIVE KNOWLEDGE AND RISKY BEHAVIORS

Several researchers have identified links between subjective knowledge and various forms of risky behaviors. Hader et al. [26] found that the willingness to invest in risky investment was related to greater subjective knowledge. A study in the context of risk information and communication showed that subjective knowledge was an important factor in the awareness of fire risk reduction behaviors [27]. Shou and Onley [16] found that tendencies to perform risky behaviors (e.g., speeding) was positively associated with subjective knowledge, especially when the outcome of the behavior was uncertain. These findings suggest that individuals with subjective knowledge are more likely to perform risky behaviors.

Similarly, individuals' risky behavior during open water activities can be explained by the concept of subject knowledge. That is, subjective knowledge should be considered in the reduction of risky behavior while doing open water activities. In a survey conducted in Australia, more than 33% of beachgoers were overconfident about their perceived knowledge of how to identify a rip current and the importance of swimming between the beach flags that were patrolled by a lifeguard [28-29]. Young adult males were found to have higher subjective knowledge and overconfidence in their swimming ability when compared to females, and this resulted in them engaging in riskier behaviors such as the consumption of alcohol when swimming, leading to a lower risk perception of drowning [30-33].

Providing safety information can help participants and coaches in open water activities gain knowledge of the danger of open water and prevent risky behaviors. An interventional study conducted by Hatfield et al. [34] aimed to investigate the effectiveness of a beach safety campaign on improving beachgoers' recognition of calm-looking rip currents. The intervention utilized posters, postcards, and brochures with rip current awareness safety messages and was distributed across Pacific Palms in New South Wales, Australia. Another area in New South Wales, Mollymook, served as the control area. Findings showed that an improvement in knowledge and safety intentions of beachgoers were observed at the post-intervention, indicating that simple safety messages could change beachgoers' perceptions and knowledge about rip currents [34].

More recently, Hamilton et al. [35] conducted an interventional study that aimed to change alcohol consumption during aquatic activities among young Australian males. The intervention involved showing a video about drowning prevention particularly targeted for males. The results showed that the intervention was effective in informing and changing the participants' perceptions of alcohol consumption around water. However, the effect was not sustained after a month. Nonetheless, these interventional studies provide support that safety information could influence individuals' subjective knowledge towards open water activities and decrease the chance of performing risky behaviors in open water settings.

BYSTANDERS AND ASSOCIATED RISKY BEHAVIORS

Bystanders play a significant role in drowning rescues and the survival rate of drowning victims. Venema et al. [36] reviewed 289 rescue reports from the Netherlands and found that the rescue and resuscitation effort by a bystander contributes positively toward the survival of a drowning victim. More than 80% of the bystander surfers in Attard et al.'s study reported that they have performed at least two rescues on Australian beaches [37]. It was also found that those with lifesaving training were more likely to perform rescues. Furthermore, cardiopulmonary resuscitation performed by bystander is crucial to drowning victims' survival [38-39]. However, not all bystanders are trained in rescuing drowning victims [40].

While bystander rescuers are crucial in saving drowning victim in open water, the number of rescuers drowning when attempting to rescue a drowning victim and causing multiple drowning incidents is not uncommon and requires close attention [41, 3]. For the past 15 years in Australia, an average of five bystander rescuers drowned every year [42]. A survey by Moran and Stanley [43] found that, in respond to a drowning emergency, many of the participants responded that they would jump in and rescue the victim, suggesting the lack of water safety awareness in ways to rescue a drowning victim. In similar vein, Petrass and Blitvich [44] designed a water safety intervention that aimed to increase young adults' rescue competency. Results showed that many of the participants lacked the knowledge and ability to perform a rescue safely, which increased the risk of them drowning as well. The intervention was able to significantly improve the knowledge and ability of the young adult rescuers [44]. Hence, it is important to understand bystanders' subjective knowledge in open water activities to minimize drowsing and injuries cases.

Overall, existing literature has shown that subjective knowledge is a significant antecedent of attitude and behavioral outcomes, such as performing risky investments [26], sharing fake news online [45] and speeding on an empty road [16]. Specifically in open water activities, higher subjective knowledge and overconfidence in swimming ability could lead to riskier behaviors, such as the consumption of alcohol when swimming [30, 33]. Understanding open water activity participants' perceived knowledge and ability towards open water safety is, therefore, a key to preventing further losses to drowning [44].

As far as it can be determined, no scale has been developed to evaluate the subjective knowledge in open water activities. Developing such a scale is important in understanding how individuals perceive their knowledge in open water activities, which can increase people's awareness of the danger of open water activities, guide coaching practices, inform policy, and reduce the rates of deaths from drowning. As such, this study aimed to develop the SKS-OWA and investigate how open water activity participants' knowledge is related to future risky behavior.

METHOD

PARTICIPANTS

This study collected data from individual participants who have participated in different types of open water activities in Singapore within the last three years and were at least 21 years old at the time of data collection. Before collecting data, this study obtained an Institute Review Board (IRB) approval from a university where the corresponding author is affiliated. Sport Singapore (Sport SG)—under the Ministry of Culture, Community and Youth, Singapore—helped in distributing the online survey link to water-based National Sport Associations and their affiliates, including public agencies and private operators, from October 2021 to February 2022. Specifically, we used data collected from October to November 2021 for the pilot study, while data collected from December 2021 to February 2022 were employed for the main study.

The questionnaire was administered using an online survey (Verint.com). An information page together with an informed consent form was provided before the commencement of the questionnaire. Respondents were briefed on the procedure of the survey, the benefits of their participation, as well as the potential risks of their participation. They were also informed that participation was voluntary, and if they wished to withdraw, they could do so at any time without any penalty. This study did not collect identifying information (e.g., name, IP address), indicating the respondents' information was kept anonymous.

SCALE DEVELOPMENT

To develop a valid and reliable scale, this study followed Hinkin et al.'s scale development procedure [46], consisting of seven steps: (a) generating the initial item, (b) assessing content adequacy, (c) developing a questionnaire, (d) conducting factor analysis, (e) evaluating reliability, (f) determining construct validity, and (g) repeating the previous process with a new data set. More specifically, first, we developed 27 initial items based on relevant studies in open water activity and safety [47-59], subjective knowledge [21, 20, 14, 23, 27,10, 59, 60] and leisure participation [61-70]. Second, this study assessed the adequacy of the item contents. Three professors in the fields of sport psychology and leisure and six practitioners in the water sports industry evaluated the content of the items to identify their face validity. Third, we developed a questionnaire and conducted a pilot study (i.e., Phase one). The items were measured using a 7-point Likert scale, ranging from strongly disagree (1) to strongly agree (7).

DATA ANALYSIS

After finishing data collection for the pilot study, we identified the reliability and validity of the measurement scale. Based on the results of the pilot test, this study redesigned the questionnaire and collected data for the main study. In the main study, we assessed the overall model fit, internal consistency, and validity of the measurement model. Data were analyzed through a three-step process using SPSS 26.0 and EQS 6.4: (a) data screening, (b) Exploratory Factor Analysis (EFA), and (c) Confirmatory Factor Analysis (CFA).

First, Mahalanobis distance was employed to identify multivariate outliers. The univariate normality of the data was assessed using significance testing with z-scores [71], and the multivariate normality was assessed using Mardia's multivariate kurtosis coefficients [72]. Next, we performed EFA, which is commonly utilized in the item purification stage as "it provides a tool for consolidating variables and for generating hypotheses about underlying processes" [73]. Specifically, we first utilized the scree plot and compared initial eigenvalues with random data eigenvalues in a parallel analysis to determine the number of factors [74]. Thereafter, we employed the principal axis factoring procedure with Promax rotation and identified the reliability of measures based on Cronbach's alpha values. Third, we removed unreliable items based on the results of EFA.

CFA using robust maximum likelihood estimation was then employed to assess the psychometric properties of the measurement scale. Specifically, to identify the goodness-of-fit for the measurement model, Root mean square error of approximation (RMSEA) and standardized root mean squared residual (SRMR), non-normed fit index (NNFI), and comparative fit index (CFI) were used. Next, for the reliability of the measurement model, the Rho, which is the composite reliability, was assessed. In addition, Satorra-Bentler scaled chi-square test (S-B χ^2) and robust standard errors were employed to interpret the results of the CFA when the normality of the data is violated [75-77]. Last, AVE values were calculated for convergent validity, and the obtained AVE values were compared with the squared correlations among constructs to assess discriminant validity [78].

Previous research showed a significant relationship between knowledge and behavioral intention in various contexts [79-80]. Thus, to assess the concurrent validity, we identified the correlations between the subfactors of subjective knowledge and an outcome variable (i.e., risky behavioral intention) using Pearson's r statistic [81-82]. This study measured risky behavioral intention using three items, which were adopted and modified from Cho's study [83], and an example item is "I intend to engage in risky open water sport activities."

RESULTS

PHASE ONE: PILOT TEST

PARTICIPANTS

A total of 260 responses were used for the pilot study (i.e., a response rate of 11.6%). Of the 260 respondents, 75.5% were males, and 24.5% were females; the average age of the research participants was 38.23 (*SD* = 10.57). 40.9% of the respondents had a four-year university degree, with 15.9% having a master's degree and 3.2% of respondents having a doctorate degree. The highest number of participants were from a monthly household income of S$10,000 or more (21.4%) followed by S$3000-S$4,999 (19.1%), S$5,000-S$6,900 (16.8%), S$7,000-S$9,999 (15.0%), and under S$3,000 (10.9%). The average period of participating in open water activities was 12 years (*SD* = 10.8), and respondents participated in open water activities on an average of 2.80 times (*SD* = 3.56) in a month.

ASSESSMENT OF THE MEASUREMENT MODEL

This study found that there were no outliers or missing values for any of the variables in the preliminary analysis. The data also showed a normal distribution pattern based on the results of skewness (-1.95 to -.48) and kurtosis (-.91 to 5.51) values [84] as shown in Table 1. When conducting the EFA, we first assessed the scree plot and compared the initial eigenvalues with random data eigenvalues to decide the number of factors. The results supported the four-factor model for the subjective knowledge scale for open water activities. Two items (PK12 and KPE6) showed low factor loadings (< ±.50) and were excluded from the main study [84].

[Insert Table 1 Here]

Second, we conducted a reliability test for the measurements using Cronbach's alpha values, and the results showed acceptable internal consistency values (α = .85 - .95; see Table 2). Finally, a total of 23 items were prepared for the main study: personal knowledge (PK; 11 items), knowledge of protective equipment (KPE; five items), environmental knowledge (EK; four items), and first aid knowledge (FAK; three items, see Table 2).

[Insert Table 2 Here]

PHASE TWO: MAIN STUDY

DEMOGRAPHIC INFORMATION AND PRELIMINARY ANALYSIS

A total of 475 responses were used for the main study, and the response rate was 17.3%. Research participants comprised of 67.5% males and 32.5% females, and the average age was 36.65 (*SD* = 13.12). As for the education level, more than 50% of the respondents had at least a bachelor's degree. Specifically, 42.8% of the respondents had a four-year university degree, with 14.9% having a master's degree and 2.2% having a doctorate degree. The highest category of monthly household income of the respondents was S$10,000 or more (22.0%), and 47.7% indicated that their monthly household income was S$5,000 or higher. The average period of participating in open water activities was 9.42 years (*SD* = 12.07), and the respondents participated in open water activities on an average of 3.63 times (*SD* = 6.28) in a month.

Before assessing the measurement model, we conducted data screening to identify univariate and multivariate outliers based on z-values and Mahalanobis distance. According to the results, we deleted 22 responses with univariate outliers based on z statistics and four responses with multivariate outliers based on Mahalanobis distance; thus, 453 responses were employed for the main study. To test the univariate normality, we examined the skewness and kurtosis of each item and found that the skewness statistics ranged from -1.06 to -.13, and the kurtosis statistics ranged from -1.10 to .88, supporting univariate normality (see Table 3). In addition, we used Mardia's multivariate kurtosis coefficients to evaluate multivariate normality and found that Mardia's multivariate kurtosis coefficient was 53.55 [72]. It indicated the multivariate normality was violated [85]. Thus, we employed Satorra-Bentler scaled statistic S-Bχ^2 [77] and robust standard errors [78] to assess the measurement model.

[Insert Table 3 Here]

ASSESSMENT OF THE MEASUREMENT MODEL

The initial model showed an acceptable fit: S-B χ^2(df) = 857.18(224), CFI = .92, NNFI = .91, RMSEA = .08, and SRMR = .07 (90% Confidence Intervals: .07 - .09) [81]. We further assessed the internal consistency and validity of the measurement model (Figure 1).

[Insert Figure 1 Here]

Specifically, the Rho coefficients of the four factors ranged from .89 for knowledge of protective equipment to .97 for personal knowledge, indicating acceptable reliability (Table 4).

[Insert Table 4 Here]

Next, we identified the convergent and discriminant validity of the measurement model. The convergent validity was assessed based on the average variance extracted (AVE) values of each factor. According to the results, all AVE values of four factors ranging from .61 for knowledge of protective equipment to .87 for first aid knowledge were greater than .50, indicating acceptable convergent validity [76] (Table 5). The discriminant validity was evaluated by comparing the correlations between four factors with the square root of AVE values. We found that the square roots of AVE values were higher than the correlations between the factors, indicating acceptable discriminant validity [76] (Table 5).

Finally, we identified the correlations between four factors of subjective knowledge and risky behavioral intention and assessed the concurrent validity of the measurement model. According to the results, the four factors showed a significant correlation with the outcome variable, where r values ranged from .14 for knowledge of protective equipment to .41 for personal knowledge. These results indicated the evidence of concurrent validity (Table 5).

[Insert Table 5 Here]

DISCUSSION

Subjective knowledge scales have been well-established in academic fields across different contexts [10, 11, 13]. However, there is no scale to measure and inform subject knowledge in open water activities. Given that more and more people visit beaches and are involved in open water activities and are at risk of drowning [7], the purpose of this study was to develop a subjective knowledge scale in the context of open water activities (SKS-OWA) to fill this gap in sports coaching literature.

The results showed the multidimensional nature of subjective knowledge in the context of maritime activity which are important to people who are involved in open water activities to increase their awareness and enhance practices. In this study, a rigorous scale development process was followed to achieve adequate psychometric properties. The development of the SKS-OWA was based on a comprehensive literature review and followed the seven steps recommended by Hinkin et al.'s scale development procedure [46]. We also conducted an expert review to assess the adequacy of the item contents and to identify face validity of the scale. In addition, EFA and CFA were performed. The results provided empirical support to the four-factor SKS-OWA and acceptable construct validity (convergent and discriminant), concurrent validity, and reliability of the scale, indicating that the SKS-OWA has adequate psychometric properties [88].

The results from the pilot study were useful in establishing the four factors (PK, KPE, EK, and FAK) and confirming the 23 items for the SKS-OWA. More importantly, the main study provided acceptable validity (convergent, discriminant, and concurrent) and reliability for the scale. Overall, the mean score ($M = 4.94$, $SD = 1.51$) for the SKS-OWA is above the 70.6% percentile. Across the four subscales, each of their mean scores was above the 64.6% percentile - PK ($M = 4.70$, $SD = 1.49$), KPE ($M = 5.85$, $SD = 1.14$), EK ($M = 4.52$, $SD = 1.72$), and FAK ($M = 4.89$, $SD = 1.88$), indicating that the current sample has a reasonable subjective knowledge in open water activities.

It is interesting to note that the PK scale has the highest mean scores among the four of them, indicating that participants in the present study valued the importance of knowledge in open water activities. Indeed, Williamson et al. argued that having a good PK played a key role in ensuring the safety of participants, and it allowed participants to identify potential dangers, such as rip currents [86]. Studies have highlighted the importance of subjective knowledge than objective knowledge for information receptivity, even though these are mediated by individual attitudes. The reason is because the more the people know, they are likely to comply as they understand the importance and impact of the coaching/policy initiative. On the contradictory, those who think that they know a lot, even if what they know is not accurate, will not be receptive to any information [89-90]. These findings have practical relevance toward intended behavioral compliance in an environment that goes through structural changes, and the implementation of future practices in a specific coaching context.

It is also noteworthy to mention that knowledge about rescuing others can reduce the risk of drowning [55], while a lack of rescue knowledge can lead to negative consequences, such as multiple drowning incidents [3]. Thus, an individual's personal knowledge in open water safety plays an important role in preventing accidents and saving lives. Coaches, national federation, and policymakers should pay attention in understanding participant's subject knowledge first and ensure that coaching practices, policy, educational programs and initiatives are relevant and useful in preparing people who are involved in open water activities.

It is heartening to note that participants in the current study indicated the relatively high mean scores in their knowledge of protective equipment such as sunscreen protection. However, the actual and safe practice of sun protection warrants further verification. These concerns were echoed in earlier research where the false belief that sunscreen use allows longer sun exposure, together with "attractiveness of a tanned look" increased individuals' risk of skin cancer, despite a high knowledge median score of 6/7 [51, 87]. In this aspect, the coach can be a positive influence by encouraging his athletes to put on sun block during outdoor training and set a good example by applying sun block before outdoor trainings.

For the current study, the mean score for environmental knowledge was relatively low among the four subscales. Previous studies have warned about the damage to the marine biodiversity and sustainability of future water sport activities like scuba diving when individuals have a lack of such knowledge [88-89]. As a suggestion, the scuba diving instructors can play an active role in educating their trainees the importance of marine biodiversity and sustainability for future enjoyment of the sport.

The FAK subscale provided some preliminary indicators on the readiness of the Singapore sample in performing first aid as a rescuer. As mentioned in the literature review, such knowledge is essential in preventing drowning incidents [3, 30, 90]. In the Singapore context, it is a pre-requisite for all coaches under the National Registry of Coaches to have a valid standard first aid certificate before taking on any assignment [91]. Such a practice can equip coaches with the necessary competency to administer standard first aid and assures participants' safety, especially for open water activities.

THEORETICAL AND PRACTICAL IMPLICATIONS

Overall, the findings of this study provide us a better understanding of subjective knowledge in open water activities in several aspects. In terms of theoretical contribution, the present study found four important subjective knowledge in open water activity – PK, KPE, EK, and FAK to guide the development of the SKS-OWA scale. Researchers could use this scale to provide important information to influence policy and individuals who are involved in open water activities and help decrease the chance of risky behaviors that could lead to unfortunate consequences such as drowsing and injuries. In addition, this scale can be used to further investigate its relationship with various behavioral and psychological constructs (e.g., attitude, skills, and decision-making) in the context of open water safety to advance our knowledge.

From a practical standpoint, research showed that coaches have a profound impact on athletes' development. They shape the training environment in water sports, influence the goals set by athletes and implement training programs to optimize athletes' learning outcomes at different levels of participation [94]. Coaches or program planners can use the SKS-OWA scale to assess participants' awareness and readiness of water safety first before allowing them to embark on the actual activities. They can also use the information to tailor water activities to meet individual learning needs. For example, the coach can be a role model in wearing a life jacket and applying sunscreen protection before any door training if the KPE score is low. The coach can also help to educate their learners the importance of marine biodiversity and sustainability and have them discuss and work out concrete steps they can take for future enjoyment in water activities if the EK score is not low.

At the policy leave, information gathered from the scale can be used to guide coach education programs/workshops targeting the public with varying levels of understanding about water activities and provide specific content and materials to enhance public's subjective knowledge and readiness for open water activities to minimize danger and risky behaviors.

LIMITATIONS AND FUTURE RESEARCH

This study has several limitations. The first limitation is that this study only collected data through the online survey and showed relatively low response rates [95]. Occurrences of certain conditions may have been skewed due to a lack of participation from certain individuals or groups. Therefore, future research can employ alternative methods of data collection (e.g., mixed data collection mode design) to avoid biases and to make the study more accessible as some people may not have access to online surveys [96]. Second, we only collected data from individuals who participated in open water activities in Singapore, and the nature of the study is cross-sectional. Hence, there is a limitation in generalizing the findings of this study. Nevertheless, the innovative approach of adopting a subjective knowledge framework for an open water safety scale is possibly the first known attempt in this research field. It may spearhead future studies to adopt this alternative approach to advance our knowledge. We also encourage future research to use the SKS-OWA in samples around other regions and conduct invariance tests to identify the SKS-OWA. Finally, it is worth noting that subjective knowledge levels could differ across various water-based activities and ability groups (e.g., elite athletes versus beginners). Thus, future studies can consider including various moderating variables and investigate how subjective knowledge is related to various factors, including participants' risk perceptions [97] and attitudes [86] toward open water safety.

REFERENCES

1. Greenwood, S., & Fletcher, T. Open water swimming events, social capital, and sociality, *Event Management*, 2021, 25(6), 665-681.

2. van Tulleken, C., Tipton, M., Massey, H., & Harper, C. M., Open water swimming as a treatment for major depressive disorder, *BMJ Case Reports*, 2018. http://dx.doi.org/10.1136/bcr-2018-225007

3. Turgut, A., & Turgut, T., A study on "rescuer" drowning and multiple drowning incidents, *Journal of Safety Research*, 2012, 43(2), 129–132. https://doi.org/10.1016/j.jsr.2012.05.001

4. Begum, S. Lost at sea: At least 18 Singaporeans have died in regional waters since 2007, *The Straits Times*, 2019. https://www.straitstimes.com/singapore/lost-at-sea.

5. Wong, S. Y., & Ang, Q., Man dies after a fishing trip to Pulau Bukom goes wrong, *The Straits Times.* https://www.straitstimes.com/singapore/man-dies-after-fishing-trip-to-pulau-bukom-goes-wrong, 2021, February 2.

6. Tan, C., 21-year-old man drowns after swimming with friends in Serangoon Canal, *The Straits Times*. https://www.straitstimes.com/singapore/21-year-old-man-drowns-after-swimming-with-his-friends-in-serangoon-canal, 2021, March 29.

7. Lanagan-Leitzel, L. K., & Moore, C. M., Do lifeguards monitor the events they should? *International Journal of Aquatic Research and Education*, 2010, 4, 241–256.

8. World Health Organization, Drowning, *World Health Organization.* https://www.who.int/news-room/fact-sheets/detail/drowning, 2021, April 27.

9. Van Beeck, E. F., Branche, C. M., Szpilman, D., Model, J. H., & Bierens, J. J. L. M. A new definition of drowning: Towards documentation and prevention of a global public health problem, *Bulletin of the World Health Organization*, 2005, 83(11), 853–856.

10. Liu, Y., Hong, Z., Zhu, J., Yan, J., Qi, J., & Liu, P., Promoting green residential buildings: Residents' environmental attitude, subjective knowledge, and social trust matter, *Energy Policy*, 2018, 112, 152–161.

11. Lipkus, I. M., Samsa, G., & Rimer, B. K., General performance on a numeracy scale among highly educated samples, *Medical Decision Making*, 2001, 21(1), 37–44. https://doi.org/10.1177/0272989X0102100105

12. Morean, M. E., & Corbin, W. R., Subjective response to alcohol: A critical review of the

literature, *Alcoholism: Clinical and Experimental Research*, 2010, 34(3), 385–395. https://doi.org/10.1111/J.1530-0277.2009.01103.X

13. Shockley, K. M., Ureksoy, H., Rodopman, O. B., Poteat, L. F., & Dullaghan, T. R., Development of a new scale to measure subjective career success: A mixed-methods study, *Journal of Organizational Behavior*, 2016, 37(1), 128–153. https://doi.org/10.1002/JOB.2046

14. Flynn, L. R., & Goldsmith, R. E., A short, reliable measure of subjective knowledge, *Journal of Business Research*, 1999, 46(1), 57–66.

15. Phillips, W. J., Asperin, A., & Wolfe, K., Investigating the effect of country image and subjective knowledge on attitudes and behaviors: US Upper Midwesterners' intentions to consume Korean Food and visit Korea, *International Journal of Hospitality Management*, 2013, 32, 49-58.

16. Shou, Y., & Olney, J. Attitudes toward risk and uncertainty: The role of subjective knowledge and affect, *Journal of Behavioral Decision Making*, 2021, 34(3), 393-404.

17. Alba, J. W., & Hutchinson, J. W. Knowledge calibration: What consumers know and what they think they know, *Journal of Consumer Research*, 2000, 27(2), 123–156. https://doi.org/10.1086/314317

18. Brucks, M., The effects of product class knowledge on information search behavior. *Journal of Consumer Research*, 1985, 12(1), 1. https://doi.org/10.1086/209031

19. Park, C. W., & Lessig, V. P., Familiarity and its impact on consumer decision biases and heuristicsm, *Journal of Consumer Research*, 1981, 8(2), 223. https://doi.org/10.1086/208859

20. Ellen, P. S., Do we know what we need to know? Objective and subjective knowledge effects on pro-ecological behaviors, *Journal of Business Research*, 1994, 30(1), 43–52.

21. Aertsens, J., Mondelaers, K., Verbeke, W., Buysse, J., & van Huylenbroeck, G., The influence of subjective and objective knowledge on attitude, motivations and consumption of organic food, *British Food Journal*, 2011, 113(11), 1353–1378.

22. Jin, H. J., & Han, D. H., Interaction between message framing and consumers' prior subjective knowledge regarding food safety issues, *Food Policy*, 2014, 44, 95–102. https://doi.org/10.1016/j.foodpol.2013.10.007

23. Hadar, L., & Sood, S., When knowledge is demotivating: Subjective knowledge and choice overload, *Psychological Science*, 2014, 25(9), 1739–1747.

24. Tassiello, V., & Tillotson, J. S., How subjective knowledge influences intention to travel? *Annals of Tourism Research*, 2020, 80, January, 102851. https://doi.org/10.1016/j.annals.2019.102851

25. Kirkpatrick, A. W., The spread of fake science: Lexical concreteness, proximity, misinformation sharing, and the moderating role of subjective knowledge, *Public Understanding of Science*, 2021, 30(1), 55-74.

26. Hadar, L., Sood, S., & Fox, C. R., Subjective knowledge in consumer financial decisions, *Journal of Marketing Research*, 2013, 50(3), 303–316. https://doi.org/10.1509/jmr.10.0518.

27. Liu, T., & Jiao, H., How does information affect fire risk reduction behaviors? Mediating effects of cognitive processes and subjective knowledge, *Natural Hazards*, 2018, 90(3), 1461–1483.

28. Brighton, B., Sherker, S., Brander, R., Thompson, M., & Bradstreet, A., Rip current related drowning deaths and rescues in Australia 2004-2011, *Natural Hazards and Earth System Science*, 2013, 13(4), 1069–1075. https://doi.org/10.5194/nhess-13-1069-2013.

29. Sherker, S., Williamson, A., Hatfield, J., Brander, R., & Hayen, A., Beachgoers' beliefs and behaviours in relation to beach flags and rip currents, *Accident Analysis and Prevention*, 2010, 42(6), 1785–1804

30. Franklin, R. C., Scarr, J. P., & Pearn, J. H., Reducing drowning deaths: The continued challenge of immersion fatalities in Australia. *Medical Journal of Australia*, 2010, 192, 123-126.

31. Howland, J., Hingson, R., Mangione, T. W., Bell, N., & Bak, S., Why are most drowning victims men? Sex differences in aquatic skills and behaviors, *American Journal of Public Health*, 1996, 86(1), 93–96. https://doi.org/10.2105/AJPH.86.1.93

32. McCool, J. P., Moran, K., Ameratunga, S., & Robinson, E., New Zealand beachgoers' swimming behaviours, swimming abilities, and perception of drowning risk, *International Journal of Aquatic Research and Education, 2008, 2(1).* https://doi.org/10.25035/ijare.02.01.02

33. Moran, K., Stallman, R. K., Kjendlie, P. L., Dahl, D., Blitvich, J. D., Petrass, L. A., McElroy, G. K., Goya, T., Teramoto, K., Matsui, A., & Shimongata, S., Can you swim? An exploration of measuring real and perceived water competency, *International Journal of Aquatic Research and Education*, 2012, 6(2), 122–135.

34. Hatfield, J., Williamson, A., Sherker, S., Brander, R., & Hayen, A. Development and evaluation of an intervention to reduce rip current related beach drowning, *Accident Analysis and Prevention*, 2012, 46, 45–51. https://doi.org/10.1016/j.aap.2011.10.003

35. Hamilton, K., Keech, J. J., Willcox-Pidgeon, S., & Peden, A. E., An evaluation of a video-based intervention targeting alcohol consumption during aquatic activities. *Australian Journal of Psychology*, 2022, 74(1), e2029221.

36. Venema, A. M., Groothoff, J. W., & Bierens, J. J. L. M., The role of bystanders during rescue and resuscitation of drowning victims, *Resuscitation*, 2010, 81(4), 434–439. https://doi.org/10.1016/j.resuscitation.2010.01.005

37. Attard, A., Brander, R. W., & Shaw, W. S., Rescues conducted by surfers on Australian beaches, *Accident Analysis & Prevention*, 2015, 82, 70-78.

38. Tobin, J. M., Ramos, W. D., Pu, Y., Wernicki, P. G., Quan, L., & Rossano, J. W., Bystander CPR is associated with improved neurologically favourable survival in cardiac arrest following drowning, *Resuscitation*, 2017, 115, 39-43.

39. Tobin, J. M., Ramos, W. D., Greenshields, J., Dickinson, S., Rossano, J. W., Wernicki, P. G., ... & CARES Surveillance Group, Outcome of conventional bystander cardiopulmonary resuscitation in cardiac arrest following drowning, *Prehospital and disaster medicine*, 2020, 35(2), 141-147.

40. Berg, I., Haveman, B., Markovic, O., van de Schoot, D., Dikken, J., Goettinger, M., Peden, AE., Characteristics of surfers as bystander rescuers in Europe, *Am J Emerg Med*. 2021, 49, 209-215. doi: 10.1016/j.ajem.2021.06.018.

41. Franklin, R. C., & Pearn, J. H., Drowning for love: The aquatic victim-instead-of-rescuer syndrome: drowning fatalities involving those attempting to rescue a child, *Journal of Paediatrics and Child Health*, 2011, 47, 44-47.

42. Lawes, J. C., Rijksen, E. J. T., Brander, R.W., Franklin, R. C., & Daw, S., Dying to help: Fatal bystander rescues in Australian coastal environments, *PLoS ONE*, 2020, 15(9), e0238317.

43. Moran, K., & Stanley, T., Readiness to rescue: Bystander perceptions of their capacity to respond in a drowning emergency, *International Journal of Aquatic Research and Education*, 2013, 7(4), 3-11.

44. Petrass, L. A., & Blitvich, J. D., A lack of aquatic rescue competency: A drowning risk

factor for young adults involved in aquatic emergencies, *Journal of Community Health*, 2018, 43(4), 688–693.

45. Kirkpatrick, A. W., The spread of fake science: Lexical concreteness, proximity, misinformation sharing, and the moderating role of subjective knowledge, *Public Understanding of Science*, 2021, 30(1), 55-74.

46. Hinkin, T. R., Tracey, J. B., & Enz, C. A., Scale construction: Developing reliable and valid measurement instruments, *Journal of Hospitality & Tourism Research*, 1997, 21(1), 100–120.
47. Baker, S. D., Validating water safety competence. *International Journal of Aquatic Research and Education*, 2019, 11(4). https://doi.org/10.25035/ijare.11.04.05

48. Bennett, H. G., Dahl, L. A., Furness, J., Kemp-Smith, K., & Climstein, M., Skin cancer and sun protective behaviours in water-based sports: A scoping review. *Photodermatology Photoimmunology and Photomedicine*, 2021, August, 1–18.

49. Brenner, R. A., Saluja, G., & Smith, G. S., Swimming lessons, swimming ability, and the risk of drowning. *Injury Control and Safety Promotion*, 2003, 10(4), 211–215.

50. Bugeja, L., Cassell, E., Brodie, L. R., & Walter, S. J., Effectiveness of the 2005 compulsory personal flotation device (PFD) wearing regulations in reducing drowning deaths among recreational boaters in Victoria, Australia. *Injury Prevention*, 2014, 20(6), 387–392.

51. Martin De Castro-Maqueda, G., Gutierrez-Manzanedo, JV., Lagares-Franco, C., de Troya-Martin, M., Sun Exposure during Water Sports: Do Elite Athletes Adequately Protect Their Skin against Skin Cancer? Int J Environ Res Public Health, 2021 Jan 19,18(2) 800. doi: 10.3390/ijerph18020800.

52. Moran, K., Water safety knowledge, attitudes and behaviours of Asian youth in New Zealand, In *Proceedings of the 2nd International Asian Health and Wellbeing Conference*, Auckland, New Zealand, 2006, 91-101.

53. Moran, K., Quan, L., Franklin, R., & Bennett, E., Where the evidence and expert opinion meet: A review of open-water recreational safety messages, *International Journal of Aquatic Research and Education*, 2011, 5(3), 251-270. https://doi.org/10.25035/ijare.05.03.05

54. Ong, M. E. H., Quah, J. L. J., Ho, A. F. W., Yap, S., Edwin, N., Ng, Y. Y., Goh, E. S., Leong, B. S. H., Gan, H. N., & Foo, D. C. G., National population based survey on the prevalence of first aid, cardiopulmonary resuscitation and automated external defibrillator skills in Singapore, *Resuscitation*, 2013, 84(11), 1633–1636.

55. Petrass, L. A., & Blitvich, J. D., Preventing adolescent drowning: Understanding water safety knowledge, attitudes and swimming ability, The effect of a short water safety intervention, *Accident Analysis & Prevention*, 2014, 70, 188-194.

56. Ramli, M. Z., Aliziyad, Y. A. M., Mohamed, J., Othman, S. F. C., Yusof, M. Z., Pa'suya, M. F., Ghafar, A. N. A., & Jabbar, W. A., Public understanding on rip currents and beach safety at teluk cempedak recreational beach of Pahang, Malaysia, *Research Square*, 2022. https://orcid.org/0000-0002-1382-475X

57. Thoonen, K., Schneider, F., Candel, M., De Vries, H., & Van Osch, L., Childhood sun safety at different ages: Relations between parental sun protection behavior towards their child and children's own sun protection behavior, *BMC Public Health*, 2019, 19(1), 1–10. https://doi.org/10.1186/s12889-019-7382-0

58. Virk, A., & Pikora, T. J., Developing a tool to measure safe recreational boating practice, *Accident Analysis & Prevention*, 2011, 43(1), 447-450.

59. Liu, Y., Hong, Z., Zhu, J., Yan, J., Qi, J., & Liu, P., Promoting green residential buildings: Residents' environmental attitude, subjective knowledge, and social trust matter, *Energy Policy*, 2018, 112, 152–161.

60. Nabi, R. L., Roskos-Ewoldsen, D., & Carpentier, F. D., Subjective knowledge and fear appeal effectiveness: Implications for message design, *Health Communication*, 2008, 23(2), 191–201.

61. Selnes, F., & Gronhaug, K., Subjective and objective measures of product knowledge contrasted. In Lutz, R.J. (Ed.), *Advances in consumer research*, 1986, 13, 67-71.

62. Ateca-Amestoy, V., Serrano-del-Rosal, R., & Vera-Toscano, E., The leisure experience, *Journal of Socioeconomics*, 2008, 37(1), 64–78.

63. Backes, C., Milon, A., Koechlin, A., Vernez, D., & Bulliard, J. L., Determinants of sunburn and sun protection of agricultural workers during occupational and recreational activities. *Journal of Occupational and Environmental Medicine*, 2017, 59(11), 1089-1094.

64. Di Bona, L. What are the benefits of leisure? An exploration using the Leisure Satisfaction Scale, *British Journal of Occupational Therapy*, 2000, 63(2), 50–58. doi:10.1177/030802260006300202

65. Forrester, S., Benefits of collegiate recreational sports participation: Results from the 2013 NASPA assessment and knowledge consortium study. *Recreational Sports Journal*, 2015,

39(1), 2-15.

66. Iwasaki, Y., & Havitz, M. E., Examining relationships between leisure involvement, psychological commitment and loyalty to a recreation agency, *Journal of Leisure Research*, 2004, 36(1), 45–72.

67. Kyle, G., Absher, J., Norman, W., Hammitt, W., & Jodice, L., A modified involvement scale, *Leisure Studies*, 2007, 26(4), 399–427.

68. Lee, Y., Dattilo, J., & Howard, D., The complex and dynamic nature of leisure experience, *Journal of Leisure Research*, 1994, 26(3), 195–211.

69. Mangione, T. W., Chow, W., & Nguyen, J., Trends in life jacket wear among recreational boaters: A dozen years (1999-2010) of US observational data, *Journal of Public Health Policy*, 2012, 33(1), 59–74.

70. Siegenthaler, K. L., & O'Dell, I., Leisure attitude, leisure satisfaction, and perceived freedom in leisure within family dyads, *Leisure Sciences*, 2000, 22(4), 281-296.

71. Ghasemi, A., & Zahediasl, S., Normality tests for statistical analysis: a guide for non-statisticians. *International Journal of Endocrinology and Metabolism*, 2012, 10(2), 486-489.

72. Mardia, K. V., Mardia's test of multinormality. In S. Kotz & N. L. Johnson (Eds.), *Encyclopedia of statistical sciences* (Vol. 5, pp. 217-221), 1985, Wiley.

73. Tabachnick, B. G., & Fidell, L. S., Using multivariate statistics (2nd Eds.), *Philadelphia: Harper and Row*, 1989.

74. Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J., Evaluating the use of exploratory factor analysis in psychological research, *Psychological Methods*, 1999, 4(3), 272–299. doi: 10.1037//1082-989X.4.3.272

75. Bentler, P. M. EQS 6 structural equations program manual. Encino, CA: *Multivariate Software*, 2005.

76. Bentler, P. M., & Dijkstra, T., Efficient estimation via linearization in structural models. In P. R. Krishnaiah (Ed.), *Multivariate analysis VI*, 1985, 9–42. Amsterdam, The Netherlands: North-Holland.Berg, I., Haveman, B., Markovic, O., van de Schoot, D., Dikken, J., Goettinger, M., & Peden, A. E. Characteristics of surfers as bystander rescuers in Europe, *The American Journal of Emergency Medicine*, 2021, 49, 209-215.

77. Satorra, A., & Bentler, P. M., Corrections to test statistics and standard errors in

covariance structure analysis. In A. von Eye & C. C. Clogg (Eds.), Latent variables analysis: Applications for developmental research, *Sage*, 1994, 399-419.

78. Fornell, C., & Larcker, D. F., Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 1981, 18(1), 39–50.

79. Johnson, C., & Ogletree, R., Knowledge and behavioural intention related to HPV vaccination among male college students, *American Journal of Health Education*, 2014, 48(5), 320-330.

80. Kim, H., & Bonn, M. A., The moderating effects of overall and organic wine knowledge on consumer behavioral intention, *Scandinavian Journal of Hospitality and Tourism*, 2015, 15(3), 295-310.

81. Fink A. Survey research methods. In P. Peterson, E. Baker, & B. McGaw (Eds.), *International encyclopedia of education*, Elsevier, 3rd Ed., 2010, 152-160.

82. Schmider, E., Ziegler, M., Danay, E., Beyer, L., & Bühner, M., Is it really robust? Reinvestigating the robustness of ANOVA against violations of the normal distribution assumption, *European Journal of Research Methods for the Behavioral and Social Sciences*, 2010, 6(4), 147-151.

83. Cho, H., Importance of leisure nostalgia on life satisfaction and leisure participation. *The Service Industries Journal*, 2020, *40*(1-2), 90-109.

84. Hulland, J., Use of partial least squares (PLS) in strategic management research: A review of four recent studies. *Strategic Management Journal*, 1999, *20*(2), 195-204.

85. Hu, L. T., & Bentler, P. M., Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives, *Structural Equation Modeling: A Multidisciplinary Journal*, 1999, 6(1), 1–55.

86. Williamson, A., Hatfield, J., Sherker, S., Brander, R., & Hayen, A., A comparison of attitudes and knowledge of beach safety in Australia for beachgoers, rural residents and international tourists, *Australian and New Zealand Journal of Public Health*, 2012, 36, 385-391. https://doi: 10.1111/j.1753-6405.2012.00888.x

87. Nikolaou, V., Stratigos, A., Antoniou, C. Sypsa, V., Avgerinou, G., Danopoulou, I., Nicolaidou, E., & Katsambas, A. D., Sun exposure behavior and protection practices in a Mediterranean population: a questionnaire-based study, *Photodermatology, Photoimmunology & Photomedicine*, 2009, 25, 132–137.

88. Lloret, J., Marin, A., Marin-Guirao L., & Carreno, M. F., An alternative approach for

managing scuba diving in small marine protected areas, *Aquatic Conservation: Marine and Freshwater Ecosystems*, 2006, 16, 579-591.

89. T Acikgoz, F., Filieri, R., & Yan, M., Psychological Predictors of Intention to Use Fitness Apps: The Role of Subjective Knowledge and Innovativeness, *International Journal of Human–Computer Interaction*, 2022, DOI: 10.1080/10447318.2022.2074668;

90. Manika, D., Papagiannidis, S., Bourlakis, M., and Clarke, R. M. (2021) Drawing on Subjective Knowledge and Information Receptivity to Examine an Environmental Sustainability Policy: Insights from the UK's Bag Charge Policy, *European Management Review, 18*(3), 249– 262. DOI: 10.1111/emre.12453

91. Toyoshima, J., & Nadaoka, K., Importance of environmental briefing and buoyancy control on reducing negative impacts of SCUBA diving on coral reefs, *Ocean and Coastal Management*, 2015, 116, 20-26.

92. Szpilman, D., Morizot-Leite, L., de Vries, W., Beerman, S., Martinho, F. N. R., Smoris, L., Lofgren, B., & Webber, J., First aid courses for the aquatic environment. In J. Bierens (Ed.). *Drowning, Springer-Verlag Berlin Heidelberg*, 2014, 659-666. DOI 10.1007/978-3-642-04253-9_101

93. *National registry of coaches* (n.d.) Sport Singapore. Retrieved February 7, 2023, from https://www.sportsingapore.gov.sg/athletes-coaches/coaches-corner/national-registry-of-coaches

94. Koh, K. T., Camiré, M., Bloom, G. A., & Wang, C. K. J. (2017). Creation, implementation, and evaluation of a values-based training program for sport coaches and physical education teachers in Singapore. *International Journal of Sports Science & Coaching,* 768 12(6), 795-806. DOI: 10.1177/1747954117730987

95. Nulty, D. D., The adequacy of response rates to online and paper surveys: What can be done? *Assessment and Evaluation in Higher Education*, 2008, 33(3), 301-314.

96. Groves, R.M. Fowler, F.J., Couper, M.P., Lepkowski, J.M., Singer, E., & Tourangeau, R., Survey methodology, *John Wiley & Sons*, 2004.

97. Slovic, P., The perception of risk, *Earthscan Publications*, 2000.

Figure 1.

The Hypothesized Measurement Model for Subjective Knowledge Scale for Open Water Activity

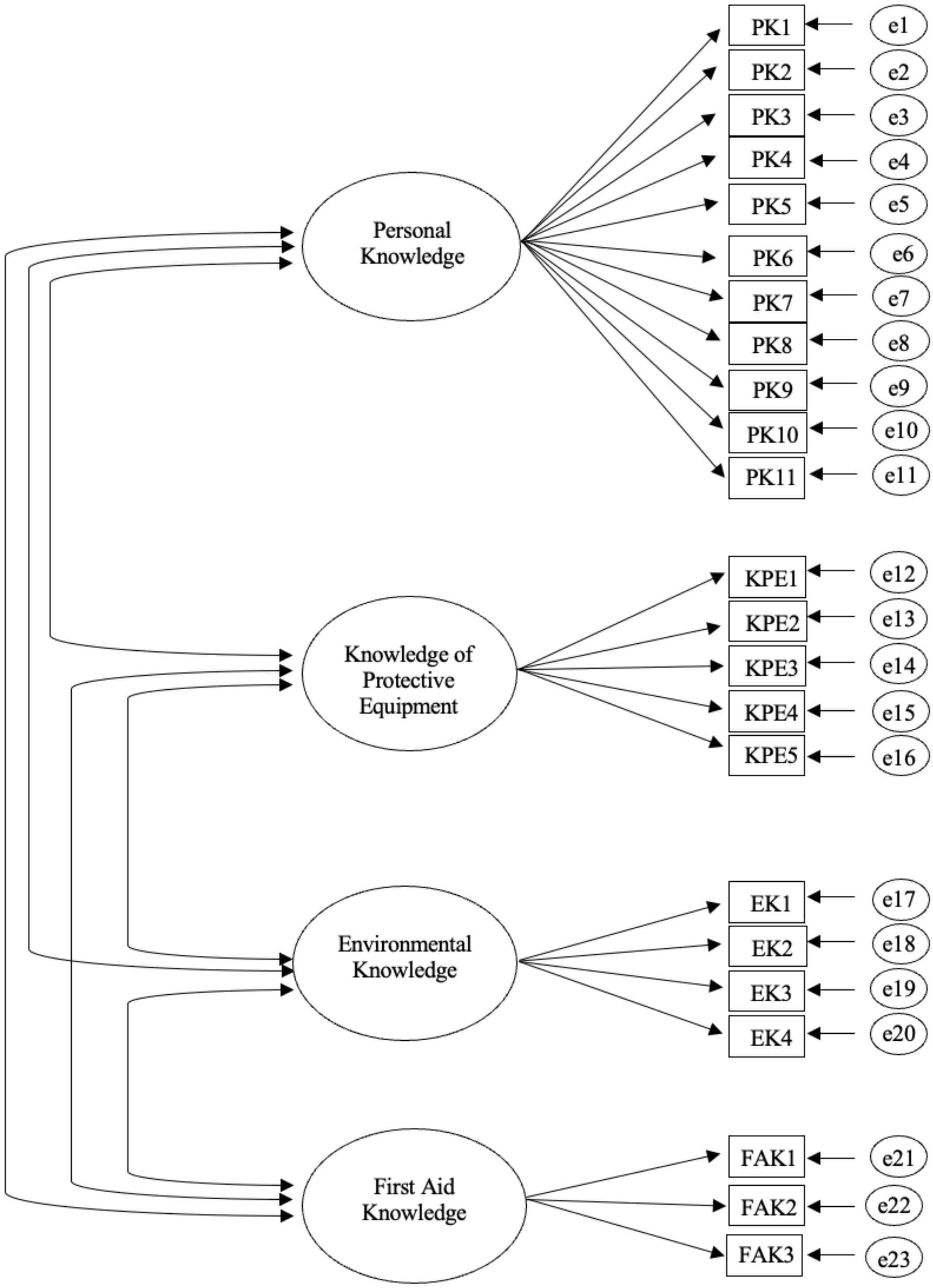

Table 1. Descriptive Statistics for the Measures in the Pilot Study (N = 260)

Factor and item	M	SD	Skewness	Kurtosis
Personal Knowledge				
(PK1) I know pretty much about open water safety.	5.45	1.23	-1.06	1.33
(PK2) I know how to judge the safety of activity in open water areas.	5.41	1.22	-.89	1.00
(PK3) I think I know enough about open water safety to feel confident when I participate in any open water activity.	5.38	1.29	-1.20	1.69
(PK4) I feel very knowledgeable in open water safety.	4.94	1.39	-.77	.38
(PK5) Among my circle of friends, I am one of the "experts" in open water safety.	4.45	1.56	-.38	-.34
(PK6) Compared to most other people, I know more about open water safety.	5.00	1.46	-.89	.49
(PK7) I have heard most of the open water safety-related issues.	4.85	1.33	-.72	.31
(PK8) When it comes to open water safety, I really know a lot.	4.33	1.47	-.34	-.24
(PK9) I can tell if the activity in open water areas is safe or not.	4.86	1.49	-.80	.61
(PK10) I can cope with the challenges during the open water activity.	5.20	1.32	-1.09	1.31
(PK11) I know the safe ways of rescuing others without putting myself in danger.	5.37	1.46	-1.02	.55
(PK12) I know swimming and water safety survival skills.	5.62	1.31	-1.32	1.97
Knowledge of Protective Equipment				
(KPE1) I am aware of the danger that Ultraviolet Radiation can cause to my body.	5.77	1.19	-1.50	3.08
(KPE2) I know the importance of using sun screen during open water activity.	6.00	1.07	-1.71	4.41
(KPE3) I know the importance of wearing UV protective clothing during open water activities.	6.03	1.02	-1.39	2.66
(KPE4) I know when to use a life jacket.	6.19	.91	-1.55	4.05
(KPE5) I know how to use a life jacket.	6.27	.95	-1.95	5.51
(KPE6) I know how to choose a personal floating device.	5.65	1.16	-1.23	1.90
Environmental Knowledge				
(EK1) I know of the prohibited activities in Marine Protected Area.	4.68	1.71	-.61	-.66
(EK2) I know the boundary of Marine Protected Area.	4.43	1.74	-.40	-.84
(EK3) I know the penalties for violating regulations.	4.13	1.71	-.18	-.91
(EK4) I know how to maintain a safe distance from the reef.	5.05	1.58	-.88	.08
First Aid Knowledge				
(FAK1) I know how to give certified standard first aid.	5.69	1.41	-1.50	2.06
(FAK2) I know how to give cardiopulmonary resuscitation.	5.70	1.48	-1.66	2.38
(FAK3) I know how to use the automated external defibrillator.	5.47	1.69	-1.29	.72

Table 2. Factor Patter Matrix in the Pilot Study (N = 260)

Item	Personal Knowledge (α = .95)	Knowledge of Protective Equipment (α = .85)	Environmental Knowledge (α = .89)	First Aid Knowledge (α = .94)	Communality
PK1	.80	.01	-.02	.06	.68
PK2	.81	-.03	-.01	.09	.69
PK3	.83	.03	-.00	-.04	.69
PK4	.99	-.13	-.02	-.02	.80
PK5	.87	-.06	-.03	-.11	.60
PK6	.85	.03	-.11	-.05	.61
PK7	.58	.03	.07	.07	.45
PK8	.96	-.19	.09	-.04	.81
PK9	.74	.07	.04	.04	.68
PK10	.79	.09	.10	-.05	.68
PK11	.57	.06	.01	.28	.61
PK12*	.39	.22	.10	.11	.48
KPE1	.12	.62	.04	-.09	.45
KPE2	-.10	.83	-.21	.04	.56
KPE3	-.05	.90	-.14	-.06	.67
KPE4	-.18	.76	.19	.09	.61
KPE5	-.10	.74	.16	.10	.62
KPE6*	.42	.36	-.08	.13	.52
EK1	.06	.04	.83	.00	.78
EK2	.06	-.06	.90	.03	.85
EK3	-.13	-.05	.90	-.05	.65
EK4	.25	.01	.53	-.04	.48
FAK1	.12	.00	-.00	.86	.85
FAK2	.02	-.03	-.06	.99	.95
FAK3	-.09	-.01	-.01	.91	.74

Note: PK = Personal Knowledge; KPE = Knowledge of Protective Equipment, EK = Environmental Knowledge; FAK = First Aid Knowledge; *Items removed after EFA

Table 3. Descriptive Statistics of the Measures in the Main Study (*N* = 453)

Item	M	SD	Skewness	Kurtosis
Personal Knowledge				
(PK1) I know pretty much about open water safety.	4.65	1.49	-.46	-.31
(PK2) I know how to judge the safety of activity in open water areas.	4.91	1.38	-.70	.30
(PK3) I think I know enough about open water safety to feel confident when I participate in any open water activity.	4.95	1.45	-.73	.21
(PK4) I feel very knowledgeable in open water safety.	4.94	1.42	-.60	-.08
(PK5) Among my circle of friends, I am one of the “experts” in open water safety.	4.09	1.73	-.17	-.91
(PK6) Compared to most other people, I know more about open water safety.	4.56	1.60	-.44	-.46
(PK7) I have heard most of the open water safety-related issues.	4.68	1.40	-.54	-.18
(PK8) When it comes to open water safety, I really know a lot.	4.60	1.46	-.33	-.40
(PK9) I can tell if the activity in open water areas is safe or not.	4.92	1.39	-.80	.40
(PK10) I can cope with the challenges during the open water activity.	4.84	1.43	-.62	-.02
(PK11) I know the safe ways of rescuing others without putting myself in danger.	4.53	1.67	-.47	-.69
Knowledge of Protective Equipment				
(KPE1) I am aware of the danger that Ultraviolet Radiation can cause to my body.	5.85	1.11	-.94	.31
(KPE2) I know the importance of using sunscreen during open water activity.	5.78	1.16	-.97	.62
(KPE3) I know the importance of wearing UV protective clothing during open water activities.	5.50	1.34	-1.00	.88
(KPE4) I know when to use a life jacket.	6.00	1.09	-1.06	.65
(KPE5) I know how to use a life jacket.	6.10	.98	-.88	-.08
Environmental Knowledge				
(EK1) I know of the prohibited activities in Marine Protected Area.	4.14	1.83	-.13	-1.09
(EK2) I know the boundary of Marine Protected Area.	4.20	1.84	-.16	-1.10
(EK3) I know the penalties for violating regulations.	4.80	1.62	-.52	-.59
(EK4) I know how to maintain a safe distance from the reef.	4.92	1.59	-.71	-.26
First Aid Knowledge				
(FAK1) I know how to give standard first aid.	5.04	1.74	-.85	-.18
(FAK2) I know how to give cardiopulmonary resuscitation.	4.92	1.91	-.76	-.64
(FAK3) I know how to use the automated external defibrillator.	4.72	1.99	-.52	-1.09

Table 4. Factor Loadings, Composite Reliability, and AVEs of the Measurement Model

Factor	Item	λ	Rho coefficient	AVE
Personal Knowledge	PK1	.92	.97	.72
	PK2	.89		
	PK3	.90		
	PK4	.84		
	PK5	.82		
	PK6	.85		
	PK7	.76		
	PK8	.87		
	PK9	.85		
	PK10	.84		
	PK11	.78		
Knowledge of Protective Equipment	KPE1	.76	.89	.61
	KPE2	.72		
	KPE3	.73		
	KPE4	.87		
	KPE5	.82		
Environmental Knowledge	EK1	.93	.90	.69
	EK2	.93		
	EK3	.70		
	EK4	.74		
First Aid Knowledge	FAK1	.93	.95	.87
	FAK2	.96		
	FAK3	.90		

Table 5. Correlations Among the Factors of the Measurement Scale

	(1)	(2)	(3)	(4)	Risky behavioral intention
(1) Personal knowledge	.85[1]				.41*
(2) Knowledge of protective equipment	.58*	.78[1]			.14*
(3) Environmental knowledge	.66*	.40*	.83[1]		.27*
(4) First aid knowledge	.50*	.37*	.42*	.93[1]	.21*

Note. [1]Square root on AVE; *$p < .05$