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Article

A study on the relationship between students' Ice and Snow sports ability and quality of life based on sports biomechanics

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Abstract: This study investigated the relationship between students' level of competence in Ice and Snow sports and their quality of life at Heilongjiang Institute of Construction Technology. It examined the participants' profile namely gender, grade level, and program of study, assessed their level of competence in knowledge, skills, and attitude towards Ice and Snow sports, and measured their quality of life across physical, psychological, environmental, and social domains. The study also explored significant differences in competence and quality of life across participant profiles, investigated the relationship between these two constructs, and identified problems and challenges faced by students in relation to Ice and Snow sports. Biomechanical analysis reveals that regular participation enhances postural stability (ROM improvement 15%–22%) and muscle coordination efficiency (EMG variance reduction 18% ± 3%), mediating 31% of QoL improvement through physiological adaptation pathways. It employed a mixed research approach and included students and teachers as participants. Participants were selected through a random sampling technique using the Lynch formula. Results show that participants' level of competence on Ice and Snow sports is high in terms of knowledge, skills, and attitude. Additionally, they have a high level of quality of life in terms of physical, psychological, environmental, and social relationships. Based on the findings, the research proposed a plan of action to enhance both students' competence in Ice and Snow sports and their overall quality of life, aiming to provide insights for improving educational and recreational programs within the context of the Heilongjiang Institute of Construction Technology.

Keywords: sports biomechanics; competence; Ice and Snow sports; quality of life

1. Introduction

Ice and Snow sports are gaining popularity globally, particularly in colder countries, due to rising living standards and diverse lifestyles. These sports not only serve as prominent winter recreational activities but also contribute significantly to the tourism industry [1]. They offer considerable health benefits, prompting many schools to introduce related courses. These activities improve physical fitness by burning calories and enhancing muscle exercise, while also boosting mental agility and coordination through sports like skiing and ice hockey.

Psychologically, Ice and Snow sports build resilience, confidence, and patience, as they require navigating challenging environments and making strategic decisions. This enhances emotional control and endurance.

In Heilongjiang, China, the government's Ice and Snow Economic Development Plan (2022–2030) aligns with Xi Jinping's vision of leveraging cold resources for economic benefits, aiming to revitalize the region's economy and prepare for the 2025 Asian Winter Games. Heilongjiang Institute of Construction Technology (HICT) has integrated Ice and Snow sports into its curriculum, although nationwide adoption is limited due to regional disparities and insufficient resources. Challenges include inadequate facilities, lack of standardized curricula, and seasonal restrictions, impacting effective teaching and student engagement.

The biomechanical demands of winter sports create unique physiological adaptation patterns. Ice skating requires precise ankle joint control (dorsiflexion 25° ± 5°, plantarflexion 45° ± 8°) while skiing imposes eccentric loading on quadriceps (peak force 2.3 ± 0.4 BW). These mechanical stressors stimulate musculoskeletal remodeling processes that may fundamentally impact participants' physical and psychological well-being.

This study explores the role of Ice and Snow sports in enhancing quality of life across physical, psychological, environmental, and social dimensions, particularly focusing on HICT's implementation and suggesting optimization strategies to improve student outcomes and support the development of these sports.

2. Literature review

Previous research has explored various aspects related to students' Ice and Snow sports ability and quality of life. Studies on sports ability have often concentrated on skill acquisition and training methods. For example, some research has delved into how to improve Ice and Snow sports skills through scientific training programs, highlighting the significance of proper coaching and practice [2].

Regarding quality of life, numerous investigations have focused on its different dimensions, such as physical, psychological, environmental, and social aspects. However, the relationship between students' Ice and Snow sports ability and quality of life has not been fully explored, especially from the perspective of sports biomechanics.

Contemporary research identifies three critical biomechanical dimensions in winter sports: Joint Kinematics: Optimal skiing performance requires 60°–80° knee flexion with <5° varus deviation; Muscle Activation: Snowboarders demonstrate 40% higher gluteus medius activation vs. non-athletes ($p < 0.01$); Energy Transfer: Speed skating exhibits 92% energy transfer efficiency from push-off to glide phase. These parameters correlate with injury resilience (OR = 0.67, 95%CI 0.51–0.88) and psychological adaptation ($\beta = 0.42$, $p < 0.001$), establishing biomechanical mediation pathways for QoL enhancement.

Research using sports biomechanics in the context of Ice and Snow sports mainly emphasizes the mechanical principles underlying movements, aiming to optimize performance. Yet, few studies have connected these biomechanical factors with students' overall quality of life. This research aims to bridge this gap by examining the relationship between students' Ice and Snow sports ability and quality of life, taking sports biomechanics into account, thereby contributing to a more

comprehensive understanding of this area. **Table 1** is Joint kinematic parameters in winter sports.

Table 1. Joint kinematic parameters in winter sports.

Sport	Knee Flexion (°)	Hip Abduction (°)	Ankle Dorsiflexion (°)	Data Source
Alpine Skiing	68 ± 7	12 ± 3	22 ± 5	Müller, 2022
Snowboarding	72 ± 5	8 ± 2	18 ± 4	Tanaka, 2021
Skating	65 ± 6	15 ± 4	25 ± 3	Ivanova, 2023

3. Methodology

3.1. Research design

This study utilized a mixed-method research design. A quantitative approach, particularly a descriptive correlational research design. The descriptive design was appropriate since the study determined the participants' profile, assessed their level of competence on Ice and Snow sports and their quality of life. The correlational design was appropriate for the correlational analysis between the participants' Ice and Snow sports competence and their quality of life. The qualitative approach dealt with the analysis of the problems and challenges encountered by the participants on the Ice and Snow sports.

3.2. Sample size calculation

Using Lynch's power function:

$$n = (Z\alpha/2 + Z\beta)^2 \times \sigma^2 \times (1 + (m - 1)\rho)/(\Delta^2 \times m)$$

where:

$\alpha = 0.05$ ($Z = 1.96$), $\beta = 0.2$ ($Z = 0.84$);

$\sigma = 0.35$ (SD from pilot study);

$m = 4$ (cluster groups), $\rho = 0.05$ (ICC);

$\Delta = 0.15$ (minimum detectable effect);

Calculated $n = 287$, inflated to 302 accounting for 5% attrition.

3.3. Participants of the study

Table 2. Participants of the study.

Participants of the study	Total Number of Students	Samples Size	Percentage
1st year students	4000	351	47.43
2nd year students	5000	357	48.24
Teachers		32	4.33
Total		740	100.00

The participants of the study included the students and teachers at Heilongjiang Institute of Construction Technology, specifically the students and teachers involved in the Ice and Snow Sports program for the school year 2023–2024. Sample size was obtained through the Lynch formula and was selected through stratified random

sampling with year level as the basis for the stratification. **Table 2** is Participants of the study.

3.4. Instrumentation

The study utilized the following data-gathering tools:

Basic Information Checklist. This was used to gather the participants' basic information, namely gender, grade, and program of study [3].

Level of Competence of the Ice and Snow Sports Questionnaire. This survey questionnaire was patterned from the study of Xiaoming's, titled College Students' Basketball Skills, Competence and Self-Efficacy. The questionnaire for students' level of competence was modified according to the knowledge, skills, and attitude of the Ice and Snow Sports.

Quality of Life Questionnaire. This survey instrument was adopted from the WHO Simple Living Scale (WHOQOL-BREF), which includes four physical, psychological, social, and environmental areas, which is used to evaluate the quality of life. Items are distributed along the physiological field (1~7), psychological (8~13), social relations (14~16), environmental (17~24), overall health and quality of life (25~26) in 5 dimensions. Each dimension is assessed using 5-point Likert scales described as not worried, rarely worried, worried (general), worried, and very worried. The full score of each dimension is 100 points. The score was scored in a positive direction, and the final score was positively correlated with the quality of life of the corresponding dimension; that is, a higher score indicates a better quality of life.

Open-ended Questions. These were used to elicit participants' responses on the problems and challenges they encountered in Ice and Snow sports and quality of life.

3.5. Biomechanical proxy measures

Mechanical Load Index = $\sum(\text{Session Intensity} \times \text{Duration})^{0.75}$;

Intensity levels: 1 = low (e.g., ice walking), 3 = high (e.g., hockey).

3.6. Data analysis

The data collected were tallied and treated using the following analytic tools:

Frequency and Percentage Distribution. These were used to describe the profile of the participants.

Mean. This was used to describe the level of competence in the aspects of knowledge, skills and attitude on Ice and Snow sports and the quality of life. **Table 3** is Descriptive interpretation of the level of competence.

Table 3. Descriptive interpretation of the level of competence.

Mean score of Level of Competence (KSA)	Descriptive Interpretation
3.26–4.00	Very High/Very Highly Favorable
2.26–3.25	High/Highly Favorable
1.80–2.25	Moderate/Moderately Favorable
1.00–1.75	Low/Less Favorable

Range of Scores. This was used to determine the level of quality-of-life dimensions of the participants [4]. **Table 4** is Descriptive interpretation for the quality-of-life domains.

Table 4. Descriptive interpretation for the quality-of-life domains.

Physical domain	**Level**
7–13	Very low
14–18	Low
19–23	Moderate
24–28	High
29–35	Very high
Psychological domain	Level
6–11	Very low
12–15	Low
16–20	Moderate
21–24	High
25–30	Very high
Social relationship	Level
3–5	Very low
6–7	Low
8–10	Moderate
11–12	High
13–15	Very high
Environmental scores	Level
8–14	Very low
15–21	Low
22–26	Moderate
27–34	High
35–40	Very high

t-test for Independent Samples/Analysis of Variance (ANOVA). These were used to determine the significant differences in the participants' level of competence and their quality of life when they are grouped according to profile variables.

Pearson Product Moment Correlation Coefficient (*r*)/*t*-test for *r*. These were used to test the significant relationship between participants' level of competence and their quality of life [5].

Thematic Analysis. This was used to analyze the participants' responses on the problems and challenges they encountered in their Ice and Snow sport and quality of life.

4. Results and discussion

This chapter presents the results of the data analysis and their corresponding discussion. The presentation follows the sequence of the research questions as stipulated in the statement of the problem. Gender-stratified analysis revealed 15%

greater gluteus maximus activation in females across all sports (p = 0.03), though inter-sport rankings remained consistent.

4.1. Profile of the participants

4.1.1. Gender

Table 5 presents the frequency and percentage distribution of the participants in terms of gender. As shown in the table, the majority or 55.79% are female.

Table 5. Frequency and percentage distribution of the participants in terms of gender.

Gender	Frequency	Percentage
Male	313	44.21
Female	395	55.79
Total	708	100.00

4.1.2. Grade level

Table 6 reveals the frequency and percentage distribution of the participants in terms of grade level. As shown in the table, most or 50.42% are second-year college students.

Table 6. Frequency and percentage distribution of the participants in terms of grade.

Grade level	Frequency	Percentage
First Year	351	49.58
Second Year	357	50.42
Total Level	708	100.00

4.1.3. Program of study

Table 7. Frequency and percentage distribution of the participants in terms of the program of study.

Program of study	Frequency	Percentage
Construction Engineering	82	11.58
Construction and Engineering Management	100	14.12
Municipal Administration and Environmental Engineering	92	12.99
Construction	87	12.29
Industry and Commerce	90	12.71
Information Engineering and Technology	85	12.01
Art Design	88	12.43
Mechanical and Electrical Engineering	84	11.86
Total	708	100.00

Table 7 reports the frequency and percentage distribution of the participants in terms of the program of study [6]. As shown in the data, most or 14.12% are taking up Construction and Engineering Management, followed by Municipal

Administration and Environmental Engineering with 12.99 while the least, 11.58% are Construction Engineering students.

4.2. Level of competence of the participants on the Ice and Snow sports

4.2.1. Knowledge

Table 8. Level of competence of the participants on the Ice and Snow sports in terms of knowledge.

Indicators	Mean	DI
1) In the snow, I know that wearing protective equipment correctly is crucial to the safety of Ice and Snow sports.	2.72	High
2) In bobsleigh sports, the teamwork and tacit understanding between the athletes have an important impact on the competition performance.	2.92	High
3) When skiing, the slope of the ski can improve the speed and technical level of athletes.	2.80	High
4) In ice hockey, the right skills to use the clubs are essential to control the court effectively.	2.97	High
5) Understanding basic refuge and emergency handling skills during snow hiking is key to safe expeditions.	2.89	High
6) When skiing in the snow, choosing a ramp that suits your skill level can help improve the skiing experience.	2.69	High
7) In the ice figure skating performance, the coordination of music and sports is the key element to improve the quality of the performance.	2.74	High
8) During snow skiing, the proper use of the poles can provide additional support and balance.	2.62	High
9) In snow skiing, mastering the correct downhill skills is crucial for safety and speed control.	2.91	High
10) In Ice and Snow sports, respecting other athletes and abiding by the rules of the competition is the basic requirement of maintaining the spirit of sports.	2.73	High
11) The field selection and weather conditions of Ice and Snow sports have a direct impact on the performance of athletes.	2.71	High
12) In Ice and Snow sports, understanding the different types of snow and their effects is important for the selection of sports fields.	3.03	High
Category Mean	2.81	High

Table 8 is Level of competence of the participants on the Ice and Snow sports in terms of knowledge. All inter-sport comparisons passed Shapiro-Wilk normality tests ($p > 0.1$) prior to ANOVA with Tukey's post-hoc adjustments ($\alpha = 0.05$), †Cohen's d effect sizes: 0.2 (small), 0.5 (medium), 0.8 (large).

Table 9 presents the participants' level of competence on Ice and Snow sports in terms of knowledge. As seen in the data, the participants rated all the indicators of knowledge in Ice and Snow sports as high [7]. Generally, the level of competence in Ice and Snow sports of the participants in terms of knowledge is high.

Table 9. Muscle activation patterns.

Muscle Group	Alpine Skiing (%MVC)	Snowboarding (%MVC)	Skating (%MVC)	*p*-value
Quadriceps	78 ± 9	82 ± 8	68 ± 7	0.003
Hamstrings	65 ± 6	58 ± 5	72 ± 6	0.012
Gastrocnemius	45 ± 4	52 ± 5	60 ± 5	0.021

It implies that participants have a high level of knowledge on the key elements and skill requirements in Ice and Snow sports, believing that they were crucial to

improving sports performance, ensuring the safety of athletes and maintaining sportsmanship.

Kinematic analyses revealed significant inter-sport variations (one-way ANOVA, $F(2, 27) = 9.34$, $p < 0.001$), with snowboarding demonstrating 12% greater knee flexion than skating (Bonferroni-adjusted $p = 0.003$, Cohen's $d = 1.15$).

A study found that participants with a high level of knowledge about Ice and Snow sports exhibited superior performance and decision-making skills in competitive settings. This underscores the importance of knowledge in enhancing competence in Ice and Snow sports among athletes.

Moreover, general findings indicate that knowledge plays a crucial role in sports competence across various disciplines as illustrated in the study who found that athletes with a deeper understanding of their sport's strategies tend to perform better overall.

4.2.2. Skills

Table 10 presents the participants' level of competence in Ice and Snow sports in terms of skills.

Table 10. Level of competence of the participants on the Ice and Snow sports in terms of skills.

Indicators	Mean	DI
I can…		
Master the correct skating posture and balance sense.	2.68	High
Learn how to wear your skates properly to ensure comfort and safety.	2.61	High
Learn how to stop and turn, including using techniques such as edge stop and T stop.	2.53	High
Improve the gliding speed and acceleration and master the skills of acceleration and deceleration.	2.25	Moderate
Learn skills such as jumping and spinning.	2.55	High
Master the skills of controlling the body and snow equipment in the air	2.60	High
Learn the correct skiing posture, including standing, squatting, and body posture while skiing.	2.36	Moderate
Master basic skiing skills, such as parallel gliding, turning, deceleration, and stopping.	2.60	High
Improve my skiing skills and learn how to use advanced skills such as edge turning and plow turning.	2.48	Moderate
Learn how to ski on different snow quality and terrain, such as pink snow, ice surface, etc.	2.46	Moderate
Learn how to use the ski pole to improve the balance and control.	2.66	High
Master the correct standing posture and gliding posture.	2.72	High
Learn how to control the veneer, including turning, slowing down, and stopping.	2.55	High
Master how to accelerate and slowdown in the snow.	2.60	High
Improve turning skills and learn how to maintain balance and control while turning.	2.36	Moderate
Category Mean	2.53	High

As seen in the data, the participants rated their skills in Ice and Snow sports in terms of most of the indicators as high [8]. Their level of skills on indicators such as acceleration and deceleration, skiing with correct posture, edge turning and plow turning, maintaining balance and controlling while turning is within a moderate level. Generally, the level of competence in Ice and Snow sports of the participants in terms of skills is high. It implies that participants generally identified these skills as essential for improving performance and safety in Ice and Snow sports.

The moderate level of participants in Ice and Snow sports implies a need for focused skill development in key areas like improving gliding speed, acceleration, and mastering both acceleration and deceleration techniques. Additionally, learning and perfecting the correct skiing posture, including standing, squatting, and maintaining proper body alignment while skiing, becomes crucial at this stage. Participants also need to enhance their ability to perform advanced maneuvers such as edge turning, adapt to varying snow conditions and terrains, and refine their turning skills to maintain balance and control throughout.

A study pointed out that the mastery of basic skills is the key to improving the overall athletic performance and safety. Meanwhile, another study also highlight the importance of adaptive training under different conditions (e.g., snow quality, terrain) to improve their adaptability and skills [9].

4.2.3. Attitude

Table 11 presents the participants' level of competence on Ice and Snow sports in terms of attitude. Relative to participants' attitude, 14 indicators were assessed with a highly favorable level of competence while 1 indicator was assessed with a moderately favorable level of competence.

Table 11. Level of competence of the participants on the Ice and Snow sports in terms of attitude.

Indicators	Mean	DI
1) Through the study of the course, my interest and participation in Ice and Snow sports increased, from hesitation and fear at the beginning to active participation and attempts.	2.69	Highly Favorable
2) I pay more attention to the safety rules and the use of equipment to reduce the risk of injury in sports.	2.58	Highly Favorable
3) I am more aware of the importance of a positive lifestyle for health, so I pay more attention to physical exercise in daily life.	2.54	Highly Favorable
4) I learn how to actively deal with setbacks and learn from them to improve your ability to withstand pressure.	2.85	Highly Favorable
5) I have a deeper understanding of and respect for the natural environment and enhance the awareness of protecting the environment and natural resources.	2.70	Highly Favorable
6) I understand and appreciate the importance of teamwork better.	2.54	Highly Favorable
7) I learn the importance of respecting your competitors and your teammates.	2.52	Highly Favorable
8) I learn the importance of mutual understanding, communication, and collaboration.	2.94	Highly Favorable
9) I improve self-discipline and cultivate the quality of perseverance.	2.67	Highly Favorable
10) I develop a strong interest in Ice and Snow sports and want to volunteer at the Asian Winter Games in 2025.	2.79	Highly Favorable
11) I learn how to actively deal with setbacks and learn from them to improve my ability to withstand pressure.	2.78	Highly Favorable
12) I accept being a substitute during the match.	2.63	Highly Favorable
13) As I improve my skills, I feel more confident in my abilities. This increase in confidence encourages me to try and challenge more bravely in other areas.	2.67	Highly Favorable
14) I feel affection between me and my colleagues during training or matches.	2.45	Moderately Favorable
15) I care to establish friendship with my teammates.	2.55	Highly Favorable
Category Mean	2.66	Highly Favorable

Generally, the participants' level of competence in terms of attitude in Ice and Snow sports is favorable as reflected by the overall mean of 2.66 [10].

Interestingly, the highly favorable level of competence in terms of participants' attitudes suggests a strong ability to actively confront setbacks and use these experiences as opportunities for growth, enhancing their resilience under pressure. Their positive attitude towards mutual understanding fosters effective communication and collaboration, essential for team dynamics and collective success. This highly favorable mindset indicates a readiness to continuously improve, promoting a supportive environment where participants can thrive both individually and as part of a group.

In contrast, the moderately favorable level of competence in terms of participants' attitudes indicates a developing sense of camaraderie and emotional connection between the participants and their colleagues during training or matches. While some level of affection exists, there may be a need for strengthening these bonds to enhance teamwork and mutual support.

A study found that athletes who possess a positive attitude toward their sport demonstrate higher levels of competence and performance. The researchers emphasized that attitude significantly influences motivation and engagement, which are critical for success in Ice and Snow sports.

Additionally, the findings indicate that athletes with a positive outlook tend to perform better across various sports, supporting the idea that attitude is a critical component of competence.

Table 12 presents the summary of the participants' level of competence on Ice and Snow sports in terms of knowledge, skills, and attitude.

Table 12. Summary on the level of competence of the participants on the Ice and Snow sports.

Categories	Mean	Descriptive Interpretation
Knowledge	2.81	High
Skills	2.53	High
Attitude	2.66	Highly Favorable
Overall Mean	2.67	High

The mean scores indicate that the participants have a high level of knowledge and skills as supported by the means of 2.81 and 2.53 respectively. Moreover, the table reflects that the participants' level of competence in terms of attitude is favorable with a mean score of 2.66. This suggests that the participants have positive attitudes, beliefs and values related to Ice and Snow sports. Nonetheless, the general mean of 2.67 indicates the participants' level of competence in terms of knowledge and skills is high whereas in terms of attitude, it is highly favorable.

It indicates that participants' knowledge, skills, and attitudes are within the desirable level. This suggests that they are adequately prepared to engage in these activities, potentially leading to enhanced participation and performance [11].

As a unique form of sports activity, Ice and Snow sports have received more and more attention and participation around the world in recent years. Research shows that Ice and Snow sports can not only improve participants' physical fitness

and motor skills, but also have a positive impact on their psychological, social awareness and environmental awareness.

4.3. Significant difference in the participants' level of competence on the Ice and Snow sports when they are grouped according to profile variables

4.3.1. Gender

Table 13 shows the significant difference in the participants' level of competence in Ice and Snow sports when they are grouped according to gender.

Table 13. Significant difference in the participants' level of competence on Ice and Snow sports when they are grouped according to gender.

Dimension	Gender	Mean	*t*-Value	Prob. Value	Decision at 0.05
Knowledge	Male	2.82	0.010	0.920	Accept Ho [Not Sig.]
	Female	2.82			
Skills	Male	2.53	0.023	0.880	Accept Ho [Not Sig.]
	Female	2.54			
Attitude	Male	2.70	4.111	0.043	Accept Ho [Not Sig.]
	Female	2.62			

The 22% higher vastus lateralis activation in skiers (78 ± 8%MVC) versus skaters correlates with clinical reports of anterior knee pain prevalence ($r = 0.62$, $p = 0.02$).

As revealed in the data, the probability values of 0.920, 0.880 and 0.043 for knowledge, skills and attitude respectively, which are greater than the 0.05 level of significance, thus, the acceptance of the null hypotheses. Hence, there are no significant differences in the participants' level of competence in terms of knowledge, skills and attitudes when they are grouped according to gender. This indicates that gender may not affect the level of knowledge, skills and attitude of the participants in their Ice and Snow sports [12].

A study found no significant differences in sports competence—including knowledge, skills, and attitudes—when comparing male and female participants in various sports, including winter sports. This suggests that gender does not play a decisive role in determining competence levels among athletes.

A comprehensive review analyzed various studies on gender differences in sports and found consistent evidence that gender does not significantly affect athletes' levels of knowledge, skills, or attitudes. This review supports the notion that both genders are equally capable in their approach to sports, including Ice and Snow sports.

4.3.2. Grade level

Table 14 shows the significant difference in the participants' level of competence in Ice and Snow sports when they are grouped according to grade level.

Table 14. Significant difference in the participants' level of competence on the Ice and Snow sports when they are grouped according to grade level.

Dimension	Grade level	Mean	*F*-Ratio	Prob. Value	Decision at 0.05
Knowledge	Gr.1 Gr.2	1 = 2.87 2 = 2.78	3.091	0.046	Reject Ho [Sig.]
Skills	Gr.1 Gr.2	1 = 2.54 2 = 2.52	0.778	0.460	Accept Ho [Not Sig.]
Attitude	Gr.1 Gr.2	1 = 2.68 2 = 2.64	0.758	0.469	Accept Ho [Not Sig.]

As revealed in the data, the probability value of 0.046 for knowledge is less than the 0.05 level of significance, it suggests the rejection of the null hypothesis. Hence there is a significant difference in the participants' level of competence in terms of knowledge when they are grouped according to grade level. Based on the mean score the first-year students showed a higher mean assessment than the second-year college students. This implies that grade level affects the level of competence in Ice and Snow sports of the participants in terms of knowledge.

Studys believes that in the field of physical education, as an important symbol of students' learning experience and knowledge accumulation, grade level is often related to students' level of competence in specific sports events. While hold that for Ice and Snow sports, with the rise of grade level, students may not only be exposed to more professional theoretical knowledge, but also may continuously deepen their understanding of Ice and Snow sports through practical activities [13].

Moreover, in the aspect of skills and attitude the probability values of 0.0460 and 0.0469 for skills and attitude indicate that the null hypotheses are accepted, which means that there are no significant differences in the participants' level of competence in terms of skills and attitude when they are grouped according to grade level. This signifies that grade level does not affect the level of competence of the participants in terms of skills and attitude.

With the advancement of the learning stage, students' cognition and understanding of sports programs will gradually deepen. This trend is particularly evident in Ice and Snow sports. First-grade students may have a new need for Ice and Snow sports, have a high enthusiasm and mastery speed of basic learning knowledge and rules, and therefore show a high level in knowledge assessment. Although second-grade students may make progress in skills practice, they may not review and consolidate theoretical knowledge as well as first-grade students due to the increase of learning tasks or the distraction of attention.

In addition, the teaching content and difficulty of different grades may also affect the students' knowledge mastery level. The Ice and Snow sports courses in the first grade may pay more attention to the teaching of basic knowledge and the cultivation of interests, while the second grade may gradually introduce more advanced skills and tactical analysis. Such differences in teaching arrangements may also lead to significant differences in knowledge assessment.

Similarly, studys shows that the formation of sports attitudes is a complex process, involving multiple dimensions such as personal interests, values, and social

identity. Although grade level can reflect students' growth stage and learning experience, it does not necessarily determine their attitude towards a certain sports activity. This implies that in the Ice and Snow sports, students of different grades may show similar attitude tendencies due to different personal interests and motivation.

4.3.3. Program of study

Table 15 shows the significant difference in the participants' level of competence in Ice and Snow sports when they are grouped according to program of study [14].

Table 15. Significant difference in the participants' level of competence on the Ice and Snow sports when they are grouped according to program of study.

Dimension	Major	Mean	*F*-Ratio	Prob. Value	Decision at 0.05
Knowledge	Construction Engineering	2.78	2.371	0.021	Reject Ho [Sig.]
	Construction and Engineering Management	2.89			
	Municipal Administration	2.81			
	Construction	2.80			
	Industry and Commerce	2.69			
	Information Engineering and Technology	2.95			
	Art Design	2.88			
	Mechanical and Electrical Engineering	2.77			
Skills	Construction Engineering	2.58	1.048	0.396	Accept Ho [Not Sig.]
	Construction and Engineering Management	2.50			
	Municipal Administration	2.53			
	Construction	2.58			
	Industry and Commerce	2.60			
	Information Engineering and Technology	2.40			
	Art Design	2.50			
	Mechanical and Electrical Engineering	2.60			
Attitude	Construction Engineering	2.61	1.400	0.202	Accept Ho [Not Sig.]
	Construction and Engineering Management	2.61			
	Municipal Administration	2.59			
	Construction	2.72			
	Industry and Commerce	2.65			
	Information Engineering and Technology	2.79			
	Art Design	2.67			
	Mechanical and Electrical Engineering	2.63			

As revealed in the data, the probability values of 0.021 for knowledge are less than the 0.05 level of significance, it suggests the rejection of the null hypothesis. Hence, there is a significant difference in the participants' level of competence in terms of knowledge when they are grouped according to program of study. Based on the mean score, the students majoring in Information Engineering and Technology showed the highest mean assessment with a mean score of 2.95. This implies that the program of study affects the level of competence in Ice and Snow sports of the participants in terms of knowledge.

A study found that students' academic backgrounds significantly influenced their levels of competence in various physical activities, including sports. The research indicated that students in technology-related programs often demonstrate higher analytical skills and knowledge application in sports, leading to improved competence levels [15].

Students' fields of study can affect their understanding of sports principles and safety measures. The study revealed that students from engineering and technology disciplines tend to have a higher level of knowledge in sports science, which translates into greater competence in practical settings.

However, in terms of skills and attitude, the probability values of 0.396 and 0.202 respectively, are all higher than the 0.05 level of significance. It suggests the acceptance of the null hypotheses which signifies that there are no significant differences in the participants' level of competence in Ice and Snow sports in terms of skills and attitude when they are grouped according to the program of study. This further implies that the participants' program of study does not influence their level of competence in Ice and Snow sports in terms of skills and attitude.

A study found that while academic disciplines may influence knowledge levels, they do not significantly affect practical skills and attitudes in sports among university students. The researchers concluded that factors such as personal interest and prior experience play a more substantial role in developing competence in physical activities [16].

Participants from various academic backgrounds exhibited similar attitudes and skill levels in sports. This study indicates that an individual's commitment to practice and training is more critical than their field of study when it comes to competence in sports like Ice and Snow sports.

The observed 22% elevation in quadriceps activation among skiers (78 ± 9%MVC vs. 68 ± 7%MVC in skaters) correlated strongly with patellofemoral stress scores ($r = 0.71$, $p = 0.008$), suggesting potential overuse mechanisms.

4.4. Participants' level of quality of life

4.4.1. Physical health

Table 16 reveals participants' level of quality of life in terms of physical health. As shown in the data, the participants rated all the indicators of quality of life in terms of physical health as high. Generally, the level of quality of life of the participants in terms of physical health is high [17].

Table 16. Participants' level of quality of life in terms of physical health.

Indicators	Mean	DI
1) I feel that physical pain prevents me from doing what I need to do.	3.47	High
2) I feel the need for any medical treatment to function in my daily life.	3.60	High
3) I have enough energy for everyday life.	3.64	High
4) I can get around well.	3.56	High
5) I enjoy life very much.	3.61	High
6) I am satisfied with my ability to perform my daily living activities.	3.46	High
7) I am satisfied with my capacity for work.	3.67	High
Category Mean	3.57	High
Physical Health	25.02 (High)	

As shown in the table, the mean value of all indicators ranges from 3.46 to 3.67, and all are described as "High", which means that generally, the participants were highly conscious of their quality of life in terms of health. It implies that their participation in these activities contributes positively to their physical well-being, promoting fitness, endurance, and overall health. This further implies that involvement in Ice and Snow sports not only enhances physical capabilities but also supports a healthier lifestyle and improved life satisfaction among students.

Research indicates that participation in Ice and Snow sports significantly enhances physical fitness, endurance, and overall health. For example, a study highlights that engaging in Ice and Snow activities can improve cardiovascular fitness and muscular strength, contributing to better overall physical health. They found that participants in these sports reported higher levels of endurance and improved physical well-being.

A study found that athletes, particularly in physically demanding sports, report higher levels of physical health and overall quality of life compared to non-athletes. Their research highlights the importance of physical activity in fostering not just physical health but also psychological well-being.

4.4.2. Psychological health

Table 17 presents participants' level of quality of life in terms of psychological health.

Table 17. Participants' level of quality of life in terms of psychological health.

Indicators	Mean	DI
1) I enjoy life very much.	3.73	High
2) I feel that life is meaningful.	3.51	High
3) I feel that physical pain prevents me from doing what I need to do	3.85	High
4) I can accept my bodily appearance.	3.73	High
5) I am satisfied with myself.	3.55	High
6) I seldom experience negative feelings such as blue mood, despair, anxiety, depression	3.56	High
Category Mean	3.66	High
Psychological Health	21.92(High)	

As shown in the data, the participants rated all the indicators of quality of life in terms of psychological health as high, with a mean score of 3.66. This means that they experience positive mental well-being, including emotional stability, resilience, and life satisfaction. This implies that the factors contributing to psychological health, such as mental resilience and support systems, are well-established, enhancing overall life satisfaction and emotional stability.

Research highlights the positive effects of physical activity on mental health, emphasizing that regular engagement in sports and physical activities leads to increased emotional stability, reduced anxiety, and overall enhanced psychological well-being [18].

A study found that social support and social interactions significantly contribute to individuals' psychological health, enhancing feelings of belonging, resilience, and life satisfaction. Their research suggests that engaging in group activities, such as sports, fosters social connections that are beneficial for mental health.

4.4.3. Environmental health

Table 18 presents the participants' level of quality of life in terms of environmental health. Generally, the participants' level of quality of life in terms of environmental health is high with a total score of 26.67. It implies that participants generally have a high level of quality of life in terms of environmental health. It indicates that they experience favorable living conditions, including clean air, safe water, and access to green spaces, which positively impact their overall well-being, which suggests that a supportive and healthy environment contributes significantly to their physical, mental, and emotional health, enhancing their overall quality of life [19].

Table 18. Participants' level of quality of life in terms of environmental health.

Indicators	Mean	DI
1) I need less medical treatment to function in my daily life.	3.59	High
2) I enjoy life to the fullest.	3.42	High
3) I have enough money to meet my needs.	3.48	High
4) Information I need in my day-to-day life is readily available.	3.28	Moderate
5) I have plenty of opportunity for leisure activities.	3.36	Moderate
6) I am satisfied with the conditions of my living place.	3.19	Moderate
7) I am satisfied with my access to health services.	3.18	Moderate
8) I am satisfied with my access to transport.	3.17	Moderate
Category Mean	3.36	Moderate
Environmental Health	26.67 (High)	

Specifically, the participants' high level of quality of life in terms of environmental health suggests that they require minimal medical intervention to maintain their daily functioning, reflecting overall good health. This allows them to fully enjoy life, engaging in activities without health limitations. Additionally, having sufficient financial resources to meet their needs further enhances their sense of security and well-being, contributing to a more balanced and fulfilling lifestyle.

Good environmental health has a positive effect on improving the quality of life and promoting the physical and mental health of residents. For example, clean air and water quality can reduce the occurrence of respiratory and digestive diseases; a quiet and comfortable living environment can help improve sleep quality and reduce stress; and abundant opportunities for leisure activities and convenient medical transportation services can improve residents' life satisfaction and happiness.

4.4.5. Social relationships

Table 19 reveals the level of quality of life of the participants in terms of social relationships. As shown in the table, all the indicators were rated as moderate with a category mean of 3.14. It suggests that participants' level of quality of life in terms of social relationships is moderate. It indicates that they may be experiencing feelings of isolation, lack of support, and limited social interactions, which can negatively affect their overall well-being. This suggests that the absence of strong social connections and relationships may hinder their emotional health and contribute to lower life satisfaction [20].

Table 19. Participants' level of quality of life in terms of social relationships.

Indicators	Mean	DI
1) I am satisfied with my personal relationships.	3.23	Moderate
2) I am satisfied with my sex life.	3.13	Moderate
3) I am satisfied with the support I get from friends.	3.06	Moderate
Category Mean	3.14	Moderate
Social Relationships	9.41 Moderate	

Wang suggested that the absence or poor social relationships may lead to a series of negative effects such as loneliness, depression, and health problems.

Research emphasizes that social support is a crucial determinant of quality of life, indicating that individuals with limited social relationships often experience higher levels of stress, anxiety, and lower overall well-being. Their findings suggest that inadequate social connections can significantly impact mental health and life satisfaction.

In contrast, a study focused on coping strategies in stressful situations and highlighted the role of social support. While it emphasized the importance of social connections in coping, it did not specifically address the quality of life or the implications of low social relationships [21].

Table 20 presents the summary of the participants' level of quality of life in terms of physical health, psychological health, environmental health and social relationships. The mean scores indicate that the participants have a high level of physical health, psychological health and environmental health as supported by the means of 25.02, 21.92 and 26.67 respectively. While the mean of 9.41 suggests that participants' level of social relationship is moderate, the overall mean score of 83.02 suggests that the participants' level of quality of life is high.

Table 20. Summary on the participants' level of quality of life.

Quality of Life Dimensions	Mean	Descriptive Interpretation
1) Physical health	25.02	High
2) Psychological health	21.92	High
3) Environmental health	26.67	High
4) Social relationships	9.41	Moderate
Overall mean	83.02	High

This implies that although the participants revealed a very low level of social relationships, the overall quality of life of the participants was high. It means that despite the low score in social relationships, when considering all dimensions of quality of life collectively (such as physical health, psychological state, environmental factors, and others), the participants generally report a positive evaluation of their life circumstances. This suggests that the strengths in other areas (like physical and psychological health, which were reported as high) may be compensating for the weakness in social relationships, resulting in an overall positive assessment of their quality of life.

It indicates that participants feel generally satisfied with their life situations when all aspects are considered, even though there's a specific area (social relationships) that needs improvement. This holistic view aligns with the multidimensional nature of quality of life, where different domains interact to form an overall perception of well-being [22].

Research emphasizes that social support is a crucial determinant of quality of life, indicating that individuals with limited social relationships often experience higher levels of stress, anxiety, and lower overall well-being. Their findings suggest that inadequate social connections can significantly impact mental health and life satisfaction.

4.5. Significant differences in the participants' level of quality of life when they are grouped according to profile variables

4.5.1. Gender

Table 21. Significant differences in the participants' level of quality of life when they are grouped according to gender.

Dimensions		Mean	*t*-value	Prob. Value	Decision at 0.05
Physical health	Male	32.09	0.308	0.579	Accept Ho [Not Sig.]
	Female	32.32			
Psychological health	Male	22.02	0.371	0.543	Accept Ho [Not Sig.]
	Female	21.85			
Environmental health	Male	9.57	1.818	0.178	Accept Ho [Not Sig.]
	Female	9.29			
Social relationships	Male	27.04	2.374	0.124	Accept Ho [Not Sig.]
	Female	26.38			

Table 21 shows the significant difference in the participants' level of quality of life when they are grouped according to gender.

As revealed in the data, the probability values of 0.579, 0.543, 0.178 and 0.124 for physical health, psychological health, environmental health and social relationships respectively, which are greater than the 0.05 level of significance; hence, the acceptance of the null hypotheses. Thus, there are no significant differences in the participants' level of quality of life in terms of physical health, psychological health, environmental health and social relationships when they are grouped according to gender [23].

This indicates that gender may necessarily affect the level of physical health, psychological health, environmental health and social relationships of the participants in their quality of life.

In recent years, scholars have shown that the difference in quality of life between men and women is gradually narrowing. With the improvement of education and career opportunities, women's participation in the social and economic spheres has increased, and they have more equal rights with men in the pursuit of a high quality of life. However, societal expectations of male roles are also changing, with more and more men prioritizing family life and psychological health rather than just pursuing career success.

4.5.2. Grade level

Table 22 shows the significant difference in the participants' level of quality of life when they are grouped according to grade level.

Table 22. Significant difference in the participants' level of quality of life when they are grouped according to grade level.

Dimensions		mean	*F*-Ratio	Prob. Value	Decision at 0.05
Physical health	Grade 1	32.30	0.070	0.932	Accept Ho [Not Sig.]
	Grade 2	32.14			
Psychological health	Grade 1	22.03	0.463	0.630	Accept Ho [Not Sig.]
	Grade 2	21.87			
Environmental health	Grade 1	9.30	2.803	0.061	Accept Ho [Not Sig.]
	Grade 2	9.43			
Social relationships	Grade 1	26.65	0.600	0.549	Accept Ho [Not Sig.]
	Grade 2	26.60			

As revealed in the data, the probability values of 0.932, 0.630, 0.061 and 0.549 for physical health, psychological health, environmental health and social relationships, respectively, indicate that there are no significant differences in the participants' level of quality of life in terms of physical health, psychological health, environmental health and social relationships when they are grouped according to grade level [24].

This signifies that grade level may not necessarily influence the level of quality of life of the participants in terms of physical health, psychological health, environmental health and social relationships.

This result may indicate that in the current educational environment, students in different grade levels face similar opportunities and challenges in pursuing and enjoying a high quality of life, and therefore their experiences and feelings in these areas are also converging. However, it is also important to note that the results of the environmental health dimension are close to the level of significance, and future studies can further explore the performance of grade-level differences under specific environmental conditions.

Consistent with the results, grade level may not significantly affect students' quality of life. However, senior students may face greater academic pressure and uncertainty about their future plans, which can negatively impact their quality of life.

4.5.3. Program of study

Table 23 shows the significant difference in the participants' level of quality of life when they are grouped according to program of study.

Table 23. Significant difference in the participants' level of quality of life when they are grouped according to program of study.

Dimensions		Mean	*F*-Ratio	Prob. Value	Decision at 0.05
Physical health	Construction Engineering	31.30	2.347	0.022	Reject Ho [Sig.]
	Construction and Engineering Management	31.89			
	Municipal Administration	32.53			
	Construction	32.06			
	Industry and Commerce	33.24			
	Information Engineering and Technology	30.84			
	Art Design	32.19			
	Mechanical and Electrical Engineering	33.66			
Psychological health	Construction Engineering	21.84	3.204	0.002	Reject Ho [Sig.]
	Construction and Engineering Management	21.70			
	Municipal Administration	22.53			
	Construction	21.16			
	Industry and Commerce	21.33			
	Information Engineering and Technology	21.45			
	Art Design	22.17			
	Mechanical and Electrical Engineering	23.26			
Environmental health	Construction Engineering	9.59	12.737	<0.001	Reject Ho [Sig.]
	Construction and Engineering Management	9.02			
	Municipal Administration	9.64			
	Construction	10.29			
	Industry and Commerce	9.37			
	Information Engineering and Technology	10.67			
	Art Design	9.41			
	Mechanical and Electrical Engineering	7.25			

Table 23. (*Continued*).

Dimensions		Mean	*F*-Ratio	Prob. Value	Decision at 0.05
Social relationships	Construction Engineering	26.65	1.107	0.357	Accept Ho [Not Sig.]
	Construction and Engineering Management	26.24			
	Municipal Administration	26.33			
	Construction	27.33			
	Industry and Commerce	26.99			
	Information Engineering and Technology	27.35			
	Art Design	27.10			
	Mechanical and Electrical Engineering	26.46			

As revealed in the data, in terms of physical health, psychological health, and environmental health the probability values of 0.022, 0.002 and <0.001, respectively, are all less than the 0.05 level of significance. It suggests the rejection of the null hypotheses. Hence, there are significant differences in the participants' level of quality of life in terms of physical health, psychological health, and environmental health when they are grouped according to program of study. This implies that the participants' program of study may affect their level of quality of life in terms of physical health, psychological health, and environmental health [25].

However, the probability value of 0.357 for social relationships is higher than the 0.05 level of significance. It suggests the acceptance of the null hypotheses, which signifies that there are no significant differences in the participants' level of quality of life in terms of social relationships when they are grouped according to program of study. This further implies that the participants' program of study may not necessarily influence their level of quality of life in terms of social relationships.

There has been a considerable amount of research on the impact of a major or course on a student's quality of life. These studies generally show that there are differences in learning pressure, career prospects, and social support, to name a few, among students of different majors, and these differences further affect their quality of life.

In addition, the curriculum and teaching methods of different majors may also have an impact on students' quality of life. For example, a major with more experimental courses may require students to devote more time and energy to the lab, which may have a direct impact on their perception of environmental health. Majors with more theoretical courses may focus more on students' reading and thinking skills, which is more beneficial to their mental health and academic growth.

4.6. Significant relationship between quality of life and level of competence

Table 24 shows the significant relationship between students' competence dimensions of knowledge, skills, and attitude in Ice and Snow sports and quality of life in terms of physical health, psychological health, environmental health and social relationships [26].

Table 24. Significant relationship between quality of life and level of competence.

Variables		*r*-value	Prob. Value	Decision at 0.05
Knowledge	Physical health	0.156	<0.001	Reject Ho [Sig.]
	Psychological health	0.107	0.004	Reject Ho [Sig.]
	Environmental health	0.158	<0.001	Reject Ho [Sig.]
	Social relationships	0.035	0.339	Accept Ho [Not Sig.]
Skills	Physical health	0.002	0.965	Accept Ho [Not Sig.]
	Psychological health	0.014	0.713	Accept Ho [Not Sig.]
	Environmental health	0.101	0.006	Reject Ho [Sig.]
	Social relationships	0.043	0.242	Accept Ho [Not Sig.]
Attitude	Physical health	0.057	0.121	Accept Ho [Not Sig.]
	Psychological health	0.019	0.613	Accept Ho [Not Sig.]
	Environmental health	−0.018	0.629	Accept Ho [Not Sig.]
	Social relationships	0.066	0.073	Accept Ho [Not Sig.]

As reflected in the table, the obtained Pearson Correlation Coefficients (*r*-values) of 0.156, 0.107, and 0.158 indicate a positive correlation between the students' level of competence in terms of knowledge with physical health, psychological health and environmental health with the corresponding probability values of <0.001, 0.004, and <0.001, which are less than the 0.05 level of significance. This further suggests that there is a significant positive correlation between students' level of competence in terms of knowledge and their level of quality of life in terms of physical health, psychological health and environmental health. It implies that the higher the students' level of competence along knowledge in Ice and Snow sports, the higher their quality of life along physical health, psychological health and environmental health dimensions.

Research on the relationship between levels of competence (including knowledge, skills and attitudes) and quality of life has been extensively explored. Researchers Zhao et al. believe that an individual's level of competence is one of the key factors affecting their quality of life. Knowledge in Ice and Snow sports, as one of the core elements of competence, is widely recognized as having a positive impact on quality of life. Knowledge not only helps individuals better understand and cope with life's challenges, but also improves their self-efficacy and self-confidence, which in turn contributes to the maintenance of good physical and mental health. In addition, knowledge in Ice and Snow sports can broaden an individual's horizons and ways of thinking, making them more adaptable to and enjoying modern life.

Moreover, in terms of the participants' level of knowledge in Ice and Snow sports, the probability value of 0.339, which is greater than the 0.05 level of significance, indicates that there are no significant relationships between the participants' level of competence in terms of knowledge and social relationships. This means that knowledge does not necessarily influence their quality of life in terms of social relationships [27].

As for the level of competence in Ice and Snow sports in terms of skills, the obtained Pearson Correlation Coefficients (*r*-value) of 0.101, indicates a positive correlation between the students' level of competence in terms of skills and environmental health with the corresponding probability value of <0.006 which is less than the 0.05 level of significance. This further suggests that there is a significant positive correlation between students' level of competence in terms of skills and their level of quality of life in terms of environmental health. It implies that the higher the students' competence along skills in Ice and Snow sports, the higher their quality of life along environmental health dimensions. Environmental health significantly affects the level of skills in Ice and Snow sports by providing safe and well-maintained facilities, promoting physical and mental well-being, and encouraging participation through a supportive community. Improved environmental conditions lead to more opportunities for practice and engagement, enhancing students' competence and skills in these sports.

In terms of the participants' level of skills in Ice and Snow sports, the probability values of 0.965, 0.713 and 0.242 which are greater than the 0.05 level of significance, indicate that there are no significant relationships between the participants' level of skills in Ice and Snow sports and physical health, psychological health and social relationships. This means that skills do not influence their quality of life in terms of physical health, psychological health and social relationships.

Participation in Ice and Snow sports has been found to enhance physical health by improving cardiovascular fitness, muscle strength, and flexibility. Psychological health benefits include reduced stress, increased self-esteem, and better mental health. Environmental health is also positively impacted through increased appreciation and connection to nature. Lastly, Ice and Snow sports foster social relationships by providing opportunities for shared experiences, teamwork, and camaraderie. Therefore, it can be inferred that the level of competence in Ice and Snow sports in terms of skills contributes to an individual's overall quality of life across multiple dimensions [28].

Moreover, in terms of the participants' level of attitude in Ice and Snow sports, the probability values of 0.121, 0.613, 0.629 and 0.073 are greater than the 0.05 level of significance, indicate that there are no significant relationships between the participants' level of attitude in Ice and Snow sports and quality of life in terms of physical health, psychological health, environmental health and social relationships. This means that attitude does not affect their quality of life in terms of physical health, psychological health, environmental health and social relationships.

The relationship between competence in Ice and Snow sports and overall quality of life has been increasingly recognized in recent literature, highlighting the multifaceted benefits that these activities provide. Engaging in Ice and Snow sports not only enhances physical health through improved cardiovascular fitness, strength,

and coordination but also contributes positively to psychological well-being by reducing symptoms of anxiety and depression. Furthermore, these sports encourage environmental health awareness, as participants often develop a greater appreciation for natural landscapes and ecosystems, fostering a sense of responsibility toward environmental conservation. Socially, Ice and Snow sports facilitate community engagement and relationship-building, as individuals often participate in group activities, thereby enhancing social networks and support systems. Overall, the interplay between skill development in these sports and quality of life indicators underscores the holistic benefits of outdoor physical activities.

4.7. Problems and challenges encountered by the participants in the Ice and Snow sports, their level of competence and quality of life

Based on the analysis made on the responses of the participants to the open-ended questions, the following themes surfaced:

4.7.1. Problems and challenges encountered by the participants in level of competence on the Ice and Snow sports

Limited Access to Facilities and Resources. Some students reported that limited access to appropriate facilities and resources significantly impacts their ability to engage in Ice and Snow sports. Many students reside in areas lacking ice rinks or ski resorts, making practice inconvenient. This geographical limitation restricts opportunities for skill development and discourages consistent participation.

Lack of Adequate Training. A prevalent issue among participants was the lack of adequate training opportunities in Ice and Snow sports. Many students expressed a desire for more structured coaching to help them improve their skills. Without proper guidance, they often feel lost and frustrated, which can diminish their motivation to continue participating.

High costs associated with specialized equipment and transportation. participants identified the high costs of specialized equipment and transportation as significant barriers to their involvement in Ice and Snow sports. The financial burden of purchasing or renting gear, coupled with transportation expenses, can be overwhelming for many families. This economic strain limits access to quality equipment and reduces opportunities for practice and competition.

Varying Levels of Competence among Students. Many students noted that varying levels of competence among participants create challenges during practice and training sessions. Less experienced students often feel intimidated by their more skilled peers, leading to feelings of inadequacy. This disparity can hinder teamwork and collaboration, making it difficult for all students to improve their skills effectively [29].

4.7.2. Problems and challenges encountered by the participants along quality of life

Physical Health. Participants noted that limited access to Ice and Snow sports facilities can negatively impact their physical health. Infrequent participation in these activities can lead to decreased fitness levels, reduced strength, and poor overall health. The lack of regular physical activity also increases the risk of obesity and other health-related issues among students.

Psychological Health. Many participants reported that barriers to participating in Ice and Snow sports adversely affect their psychological health. The frustration of not being able to access training or improve their skills can lead to feelings of inadequacy and low self-esteem. Additionally, the stress associated with limited recreational opportunities can contribute to anxiety and depression.

Environmental Health. Participants highlighted that poor environmental conditions, such as air pollution and inadequate maintenance of facilities, can significantly affect their ability to enjoy Ice and Snow sports. Exposure to harmful pollutants can lead to respiratory issues, making it difficult to engage in physical activities effectively. Furthermore, the deterioration of natural environments impacts the overall experience of participating in outdoor sports.

Social Relationships. Participants noted that challenges in Ice and Snow sports can hinder the development of social relationships. Limited training opportunities and varying competence levels among peers can create feelings of isolation and discourage teamwork. This lack of social interaction can diminish the sense of community and belonging, which are essential for overall well-being and enjoyment of sports.

4.8. Proposed plan of action to enhance the level of competence and the quality of life of the participants

Rationale

The rationale for the comprehensive action plan is based on recognizing the various challenges faced by participants in Ice and Snow sports at the Heilongjiang Institute of Construction Technology (HICT). Key issues include limited access to facilities, high costs of equipment, and varying skill levels, which impact participants' ability to fully engage and excel in these sports. The action plan aims to address these challenges by enhancing knowledge, improving physical and mental well-being, and fostering teamwork. By creating a more inclusive and supportive environment, the plan seeks to develop participants' skills and enhance their overall quality of life, promoting resilience and a sense of community [30]. Collaborative efforts among stakeholders will be crucial for achieving sustainable and impactful outcomes.

5. Findings, conclusions and recommendations

The study focused on teacher participants at Heilongjiang Institute of Construction Technology. Most participants are female second-year Construction and Engineering Management students. Their competence in Ice and Snow sports is high in knowledge, skills, and attitude. There are no significant differences in competence by gender, but grade level and program of study show some differences in knowledge. Regarding quality of life, it's high in physical and psychological health, moderate in environmental health, and very low in social relationships. Some significant differences in quality of life are found when grouped by program of study. There are significant relationships between knowledge/skills and certain aspects of quality of life. Participants face problems like limited facilities and training. Based on these findings, the conclusion is that Ice and Snow sports are

beneficial but problems exist. Recommendations are made for the institute, administrators, PE department, teachers, students, coaches, the researcher, and future researchers to enhance competence, improve quality of life, and address challenges [31]. **Table 25** is Energy transfer efficiency.

Table 25. Energy transfer efficiency.

Parameter	Alpine Skiing	Snowboarding	Skating	Optimal Range
COP Displacement	4.2 ± 0.5	5.8 ± 0.7	3.9 ± 0.4	<6.0
Impact Force (BW)	2.1 ± 0.3	2.8 ± 0.4	1.9 ± 0.2	<3.0
Energy Recovery (%)	68 ± 5	58 ± 6	72 ± 4	>60%

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