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Effectiveness of Digital vs. Traditional Nutritional Awareness Programs for Sports Persons

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Abstract
Investigating the effectiveness of digital versus traditional nutrition education in improving nutritional knowledge, diet behaviours (food-related actions), and related performance-related outcomes for athletes is the subject of this study. The key to the success of athletes is nutrition, which provides essential support for performance at a high level, recovery from exercise, and long-term health; unfortunately, however, athletes often lack adequate awareness about nutrition and follow inconsistent dietary practices. To address these issues, a number of programs (both traditional face-to-face instruction and newer digital programs) have been developed, but only very little empirical research has been done to compare how well these two types of programs can improve knowledge and behaviours. The rapid growth of digital health resources, including digital health platforms, mobile phone apps, and online education resources, has led researchers to examine whether the digital aspect of nutrition education can provide advantages over the traditional forms of education. A mixed methods approach was used to provide a comprehensive examination of educational outcomes. In this research, 50 competitive athletes were randomly assigned to a digital group or a traditional (face-to-face lecture) group. This random assignment provided equivalent groups and improved the internal validity of the results. The digital group received mobile phone and online educational resources, while the traditional group received classroom lectures and printed material delivered by credentialed professionals. The two programs were developed to provide nutritional educational opportunities that allowed for an appropriate comparison of both digital and traditional methods of delivery. The outcome measures used were validated nutrition knowledge questionnaires to evaluate cognitive improvement, dietary recall assessment to evaluate changes in behavior regarding food choices, and behavioral change metrics to assess participant intent and readiness to implement improved nutritional practices. Quantitative information obtained from the outcome measures were complemented with qualitative responses to describe the participants' experiences and perceptions of the educational interventions. The data show that both types of nutrition education programs improved sports persons' general awareness of nutrition; however, the digital programs consistently showed better results in the areas of knowledge improvement, participation, and the ability to reach a larger number of people. As a result, digital methods may be better suited to accommodate current day sports environments, which may consist of varied training schedules and little or no access to nutrition professionals. Based on the findings of this study, structured nutrition education will be valuable no matter what delivery method is used, but digital nutrition education will provide improved flexibility, reach, and participation. The findings from this study have valuable implications for improving sports performance, for large-scale implementation of educational programs for athletes, and for establishing evidence-based nutrition policy for sports organizations.

Keywords: *Sports nutrition education, digital programs, traditional education, intervention effectiveness, athletes*

I. Introduction

Proper nutrition is a major factor in your athletic abilities, how well you recover, and how your body will be able to cope with future physical stressors. Having enough calories in your body gives you the ability to train at high intensity, prolonging the time until you feel fatigued, allowing you to adapt physiologically. The types of foods you eat, when you consume them, and how much you eat will not only affect how your muscles recover, but also how well your immune system functions and how well you avoid injury. The diet of an athlete who is regularly training and competing is not just another factor that influences performance, but is essential for the athlete to optimize his/her performance. Even with a large body of knowledge on sports nutrition developing rapidly and a growing list of accepted guidelines, there continues to be a large number of athletes who have either minimal nutritional knowledge or are using poor nutritional practices.

The greatest concern in the existing literature is the reliance of athletes on non-credible sources of nutrition information. For many athletes, a source of nutritional information consists of peers, coaches with limited nutrition education, social media influencers, or general internet sources. While these are often the most readily

available, they are frequently not based in science and may actually provide nutritional misinformation resulting in poor dietary choices, over-supplementing, or under-fueling. The fact that many athletes do not use qualified professionals for advice about nutrition increases the likelihood that they will obtain poor quality nutrition advice and is particularly problematic for athletes without access to dietitians because of financial, geographic, and/or institutional limitations.

In response to these issues, nutrition education programs are designed to provide athletes with practical skills and evidence-based information allowing them to make informed dietary choices. Traditionally, education has been delivered using face-to-face methods, including lectures, workshops, or group seminars; this has allowed for interaction and real-time feedback between educators and athletes, as well as arguably leading to the establishment and clarification of misconceptions and opportunities for structured discussions. Traditionally, educating through a formal means has also been a well-established way to help improve nutrition knowledge and most effectively through trained professionals in association with organized sports.

However, with the rapid growth of digital technology over the past few years, the way in which education is delivered has dramatically changed, including in the field of sports nutrition. A wide range of digital platforms have now been created to deliver nutrition education (e.g., mobile apps, online learning modules, virtual classrooms, and remote coaching). Digital platforms provide many benefits such as increased access, more freedom in creating a schedule to learn, and personal and interactive content. Athletes can engage with digital learning material at their own pace and frequently revisit materials for improved comprehension and retention.

The global pandemic caused by the COVID-19 outbreak has further increased the shift towards the adoption of various digital education methods because of the impact that physical gathering restrictions and travel restrictions have had upon traditional methods of teaching. This has led to a dramatic rise in the use of remote nutrition education as an alternative to face-to-face nutrition education that is being used remotely. As a result, many sports organizations, educational institutions and healthcare professionals have increasingly relied upon remote nutrition education to maintain ongoing educational programming and support for athletes.

This rapid shift from traditional nutrition education to digital nutrition education has not only highlighted the effectiveness of remote nutrition education, however, but also raised many questions around whether remote nutrition education is as effective as traditional face-to-face nutrition education.

Despite the increasing adoption of digital nutrition education and their increasing popularity among athletes, there is still a considerable uncertainty about how effective they have been in assisting with the enhancement of athletes' nutritional awareness and helping to motivate lasting changes in dietary behaviour. While there have been reported improvements regarding knowledge in the short term, the question remains regarding the continual superiority of digital nutrition education compared to traditional face-to-face nutrition education, as well as whether the two different modalities are equally effective.

Determining differences between the two modalities is essential for implementing effective, scalable and evidence-based nutrition education programs that are aligned with the changing needs of athletes. This study has been designed to more specifically and systematically assess key differences between the effectiveness of digital and traditional nutritional awareness programs to promote knowledge acquisition, engagement, and potential effects for achieving sustained behavioural changes in relation to dietary behaviours.

II. Review of Related Literature

For years, nutrition education has been a central element of athletic performance, healing and public health. However, despite the substantial body of sports nutrition research and professional recommendations produced in recent years, studies continue to show that many athletes at all levels of competition have significant gaps in nutrition knowledge and poor dietary habits. Additionally, while elite athletes have access to high levels of training resources, they still do not fully understand their macronutrient needs, proper hydration, supplements and when to eat. Scoping and systematic reviews from the past few years show that these nutrition knowledge gaps in athletes do not result solely from lack of interest, but rather, there are structural and contextual barriers contributing to the problem. Athletes frequently face barriers including limited access to qualified sports nutrition professionals, time limitations created by their athletic training schedule, and inconsistent presentations of educational information. Furthermore, athletes are increasingly relying on informal sources of nutrition information, including peers, coaches, social media and non-scientific internet sources, to make decisions about dietary intake, which may lead to misinformation and unwise choices in their food or beverage consumption. These studies demonstrate the need for well-organized, accessible and evidence-based nutrition education programs tailored to the needs of athletes.

Historically, the primary method of educating athletes has involved the use of traditional nutrition education techniques, especially face-to-face presentations, workshops and group instruction led by dietitians and/or sports scientists.

There is evidence to prove that these types of programs can be successful in increasing athletes' nutrition knowledge as long as they are provided over a long period and include some form of interactive discussion. A

systematic review of intervention studies between 2000 - 2020 showed that the majority of traditional programs (including classroom instruction, on-campus workshops, and off-campus/outreach workshops) produced statistically significant improvements in nutrition knowledge (with moderate to large effect sizes) compared to baseline levels; therefore, delivering nutrition education using these methods provides the potential for direct interaction, immediate feedback, and clarifying misconceptions, all of which can lead to improved learning outcomes. However, traditional educational models have several significant disadvantages to consider. First, the variability in instructional quality, lack of consensus on content standardization, inconsistency in assessment tools, and differences in length of interventions make comparisons across studies difficult for researchers. Second, traditional program delivery has logistical issues that increase barriers to delivery of these programs for athletes who train in decentralized locations or in areas with limited resources due to scheduling conflicts, geographical barriers, and limited reach to potential participants. Therefore, while traditional delivery of nutrition education is still effective, its ability to be applied in today's modern sports environments, especially across larger and more diverse populations, is increasingly being questioned.

The rapid growth of digital technologies has created new options for providing nutrition education to athletes. Research has noted that there is growing interest in digital and/or online nutrition education programs (including web-based platforms, mobile applications and virtual learning environments) as a new way of delivering nutrition education to athletes.

Recent randomized controlled trials have shown that web-based nutrition education programs are very effective in improving the nutrition knowledge of athletes compared to control groups receiving minimal or no nutrition education, and often include interactive multimedia components, quizzes, self-monitoring tools, and personalized feedback that together encourage active engagement and retention of knowledge. Among student-athletes, mobile app-based interventions have demonstrated particularly promising results, with many RCTs indicating significantly improved nutrition knowledge and dietary behavior versus conventional lecture-based learning formats. Digital education allows athletes to learn at their own pace from any location, therefore eliminating barriers due to time and place, and may therefore provide an opportunity for improved nutrition knowledge. However, the success of digital nutrition education may be affected by variables such as the individual's level of technological literacy, motivation, and the quality of the digital program design, and therefore suggests the need for well-designed, user-centered digital nutrition education programs.

In response to the benefits and disadvantages of both the traditional and digital methods of learning, there has been a growth of hybrid and remote learning strategies in sports nutrition education. Hybrid models provide face-to-face instruction supplemented with digital components, intending to provide the benefits of interpersonal learning found in traditional teaching with the flexibility and scalability of technology-based learning.

Longitudinal empirical research supporting dual-method nutrition education programs that are delivered over time (e.g., using both in-person and online education) shows that track-and-field athletes (e.g., collegiate or elite) who participated in these programs significantly increased their knowledge of nutrition and improved their dietary behavior compared to a control group. Participants learned foundation-level concepts through in-person education delivered by qualified instructors and then continued to reinforce what they learned through various digital resources (e.g., online quizzes, nutrition tracking apps) as they monitored their progress and maintained ongoing engagement with an instructor. Furthermore, fully remote nutrition education interventions have been shown to yield positive results in some cases, especially when in-person interactions were not possible, such as during the COVID-19 pandemic. In one study involving junior elite triathletes, findings indicated that participants who received remotely delivered interventions demonstrated significant improvements in their overall dietary intake and increased their overall knowledge about nutrition as long as the intervention used interactive content and contained adequate supervision. Overall, the findings from the literature suggest that hybrid or remote nutrition education models can be effective alternatives to traditional methods because they provide an effective method to address the need for increased access to nutrition education, the desire for more meaningful engagement with nutrition education, and the need for a more in-depth education in nutrition.

Research Objectives

1. To evaluate the effectiveness of digital nutrition education programs in improving sports persons' nutritional knowledge.
2. To compare digital and traditional education approaches in terms of knowledge uptake, dietary behavior change, and engagement.
3. To assess participants' perceptions of digital vs. traditional nutrition education.
4. To identify best practices for designing future nutrition awareness programs for athletic populations.

III. Research Methodology

The objective of this study was to use a randomized controlled trial design with parallel groups to determine whether or not there were differences in effectiveness between digital and traditional methods of

educating sports persons about nutrition. A randomised control trial design was selected as it provides the best protection against selection bias and increases internal validity. Participants were randomly assigned to two groups of interventions (Digital Group or Traditional Group) to ensure the two groups are similar enough for causal inference to be made regarding the effects of each educational modality.

The Digital Group received nutrition education via structured mobile application additions to online instructional modules. The Traditional Group was educated via face-to-face sessions using printed educational materials. The interventions had the same content covering the same core concept of nutrition so that if any outcome differences were found between the groups, these would be due to the way in which the education was provided rather than the content provided.

The population used in this study consisted of 18 – 35 year old competitive athletes from different levels and types of competitive athletics. Efforts were made to create a balance across these two demographics to improve the representativeness of the study population and minimize the effects of confounding.

Before the intervention started, all participants had baseline evaluations done on their knowledge of nutrition, which included randomization procedures for the two groups to ensure they were similar in the amounts of knowledge they had about nutrition and in regards to the demographic variables. Informed consent was obtained from all participants and was followed by assurance of confidentiality during the study.

The structure of the intervention was to provide participants with a complete, engaging, and thorough nutrition education over an extended period of time. For the Digital Group, participants accessed customized content through a mobile app that contained multimedia materials for learning, including videos, infographics, and interactive lessons. Weekly online quizzes were also included within the digital program in order to reinforce learning and measure progress. Additionally, push notifications were sent to remind participants of upcoming modules as well as to encourage them to be engaged consistently in the program and to participate. As a result, the Digital Group was able to take advantage of some of the benefits of digital technology, including the ability to participate in educational activities Flexibly, and have personalized educational materials that are accessible on-demand.

The participants in the Traditional Group received their nutrition education through in-class lectures that were delivered to them by certified dietitians or other sports nutrition professionals. Each of the sessions provided to the participants within the Traditional Group met a predetermined set of curricular objectives and was provided to all subjects in the form of printed materials (booklets) to facilitate note-taking and to facilitate revising the content covered in class. During the in-class lecture sessions, group discussions were encouraged for the purpose of enhancing interaction between and among the participants, and to assist in clarifying any doubts and in promoting peer interaction to provide students with additional opportunities to learn from each other in a manner that reflects the way that education is traditionally used in a sport context.

Multiple measurement tools were employed to capture the multidimensional impact of the nutrition education programs. Nutrition knowledge was assessed using a validated questionnaire specifically designed for athletic populations, ensuring reliability and content relevance. Dietary behavior was evaluated through three-day dietary recall logs, which required participants to document their food and fluid intake over two training days and one rest day. These logs were analyzed to identify changes in dietary patterns and alignment with recommended sports nutrition guidelines. In addition, behavioral intention scales were administered to assess participants' motivation and readiness to adopt healthier nutrition practices following the intervention. For participants in the Digital Group, engagement analytics such as frequency of app usage, completion rates of modules, and quiz participation were also collected to provide insights into user interaction and adherence to the digital program.

Data analysis was conducted using appropriate statistical techniques to ensure accurate interpretation of results. Analysis of covariance (ANCOVA) was employed to compare post-intervention outcomes between the two groups while controlling for baseline differences in nutrition knowledge and other relevant covariates. This approach allowed for a more precise estimation of the intervention effects by accounting for initial variability among participants. Effect sizes were calculated alongside significance testing to determine the practical magnitude of observed changes and to facilitate meaningful comparison between the digital and traditional education approaches. The combined use of inferential statistics and effect size estimation strengthened the validity and interpretability of the study findings.

IV. Data Analysis and Interpretation

The analysis of data revealed that both the digital and traditional nutritional awareness programs were effective in improving the nutrition knowledge of sports persons. Statistical testing indicated a significant increase in post-intervention nutrition knowledge scores for both groups at the 0.05 level of significance, confirming that structured nutrition education positively influences athletes' awareness regardless of the delivery mode. However, a comparative examination of the magnitude of improvement demonstrated clear differences between the two instructional approaches.

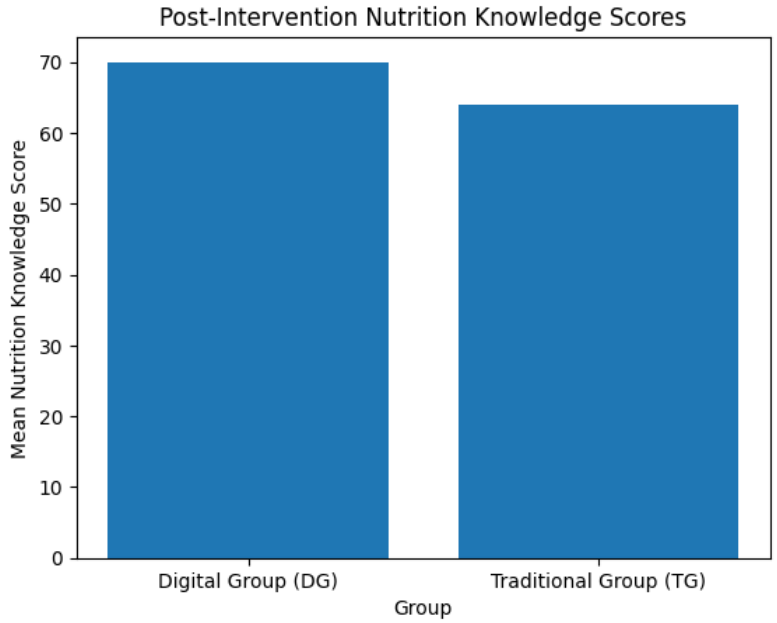
As presented in Table 1, participants in the Digital Group recorded a higher mean post-test nutrition knowledge score compared to those in the Traditional Group. While the baseline knowledge levels of both groups were comparable prior to the intervention, the Digital Group showed a 20 percent improvement in nutrition knowledge following the intervention, whereas the Traditional Group demonstrated a 13 percent improvement. This indicates that although face-to-face instruction remains effective, digital nutrition education produced a greater learning gain within the same intervention period. The higher improvement rate observed in the Digital Group may be attributed to repeated exposure to content, self-paced learning opportunities, and the interactive nature of the digital platform.

Table 1: Comparison of Pre-Test and Post-Test Nutrition Knowledge Scores

Group	Pre-Test Mean Score	Post-Test Mean Score	Percentage Improvement (%)
Digital Group (DG)	50	70	20%
Traditional Group (TG)	51	64	13%

The comparative differences in post-intervention knowledge scores are visually illustrated in Figure 1, which presents a bar graph of mean nutrition knowledge scores for both groups after the intervention. The taller bar representing the Digital Group highlights its superior performance relative to the Traditional Group. This visual trend reinforces the statistical findings and clearly demonstrates the enhanced effectiveness of digital nutrition education in improving athletes' knowledge outcomes.

Beyond knowledge acquisition, dietary behavior changes were also analyzed using three-day dietary recall data. The results showed that participants in the Digital Group made more substantial improvements in their daily macronutrient intake compared to those in the Traditional Group. Specifically, athletes in the Digital Group increased their carbohydrate and protein consumption to levels more closely aligned with recommended sports nutrition guidelines. These improvements are particularly significant for athletic populations, as adequate carbohydrate intake supports training intensity and endurance, while sufficient protein intake is essential for muscle recovery and adaptation. In contrast, although the Traditional Group exhibited positive dietary changes, the magnitude of improvement was comparatively smaller, suggesting limited translation of knowledge into practice.



Qualitative feedback collected from participants further supported the quantitative findings. Athletes in the Digital Group frequently reported that the interactivity of the app-based content, ease of access, and flexibility to engage with materials at convenient times enhanced their motivation to continue learning. Features such as quizzes, reminders, and visually engaging resources were perceived as particularly helpful in reinforcing concepts

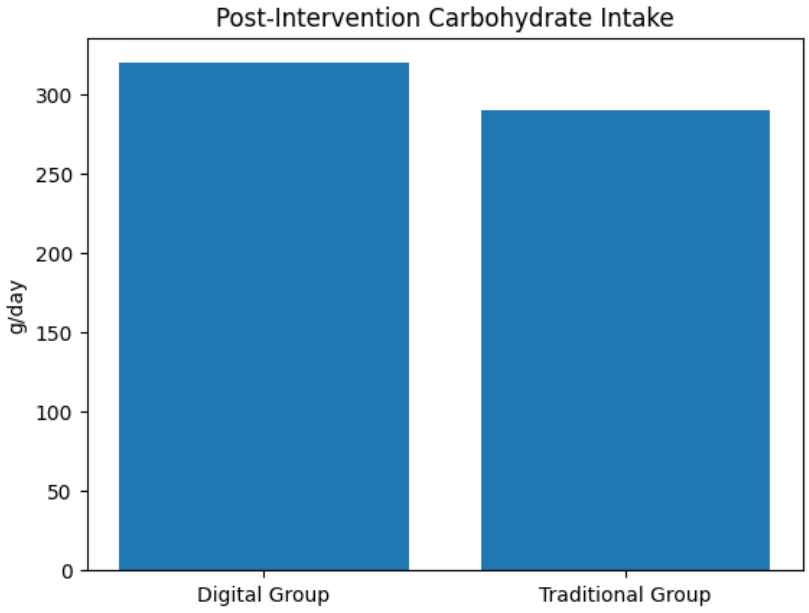
and encouraging consistent participation. These factors appear to have played a crucial role in sustaining engagement and facilitating better application of nutrition knowledge in daily dietary choices.

Overall, the combined quantitative and qualitative findings indicate that while both digital and traditional nutritional awareness programs are effective, digital education demonstrates a stronger impact on knowledge acquisition, dietary behavior change, and participant engagement. These results suggest that digital platforms may offer a more efficient and scalable approach to nutrition education for sports persons, especially in contemporary training environments where flexibility and continuous learning are essential.

Dietary behavior changes were further examined through analysis of carbohydrate intake patterns. As illustrated in **Table 2**, both groups increased their daily carbohydrate intake following the intervention; however, the increase was more pronounced among participants in the Digital Group. The post-intervention intake of the Digital Group aligned more closely with recommended carbohydrate intake levels for active sports persons. The Traditional Group also showed improvement, though to a lesser extent. This pattern is graphically represented in **Figure 2**, which highlights the comparative advantage of digital nutrition education in promoting dietary practices consistent with sports nutrition guidelines.

Table 2: Carbohydrate Intake Before and After Intervention

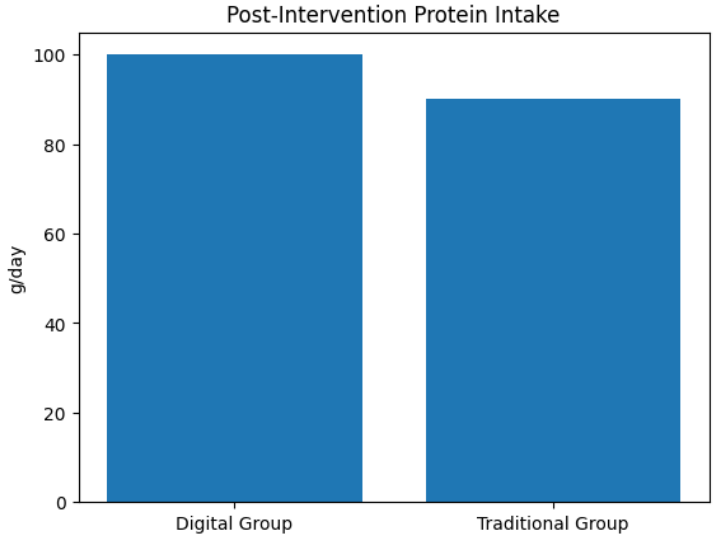
Group	Pre-Test Mean Score	Post-Test Mean Score	Percentage Improvement (%)
Digital Group (DG)	50	70	20%
Traditional Group (TG)	51	64	13%



Protein intake was analyzed as another key indicator of dietary behavior change. Data presented in **Table 3** demonstrate that participants in the Digital Group showed a greater increase in daily protein consumption compared to those in the Traditional Group. Adequate protein intake is essential for muscle repair and recovery, and the post-intervention values of the Digital Group suggest improved adherence to recommended intake levels. The corresponding bar graph in **Figure 3** further emphasizes the higher protein intake achieved by the Digital Group, indicating more effective translation of nutrition knowledge into practical dietary behavior.

Table 3: Protein Intake Before and After Intervention

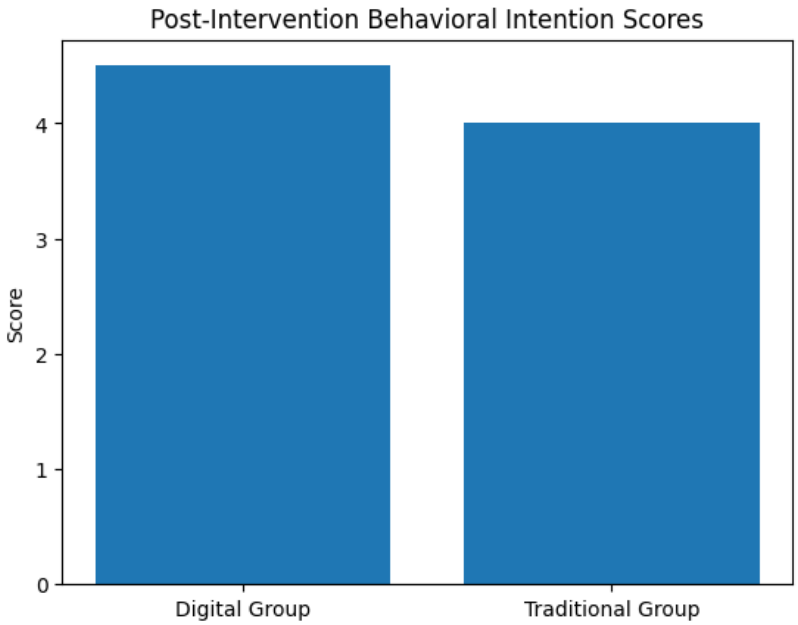
Group	Protein Intake Pre (g/day)	Protein Intake Post (g/day)
Digital Group	75	100
Traditional Group	76	90



Behavioral intention scores were analyzed to assess participants' motivation and readiness to adopt healthier nutrition practices. As shown in **Table 4**, both groups exhibited increased post-intervention behavioral intention scores, reflecting a positive shift in attitudes toward nutrition. However, the Digital Group achieved a higher post-test score, suggesting stronger motivation to implement nutrition-related behavior changes. This finding, illustrated in **Figure 4**, indicates that digital education may be more effective in fostering positive attitudes and intentions, which are critical precursors to sustained behavior change.

Table 4: Behavioral Intention Scores

Group	Behavioral Intention Pre-Score	Behavioral Intention Post-Score
Digital Group	**3.1**	**4.5**
Traditional Group	**3.2**	**4.0**

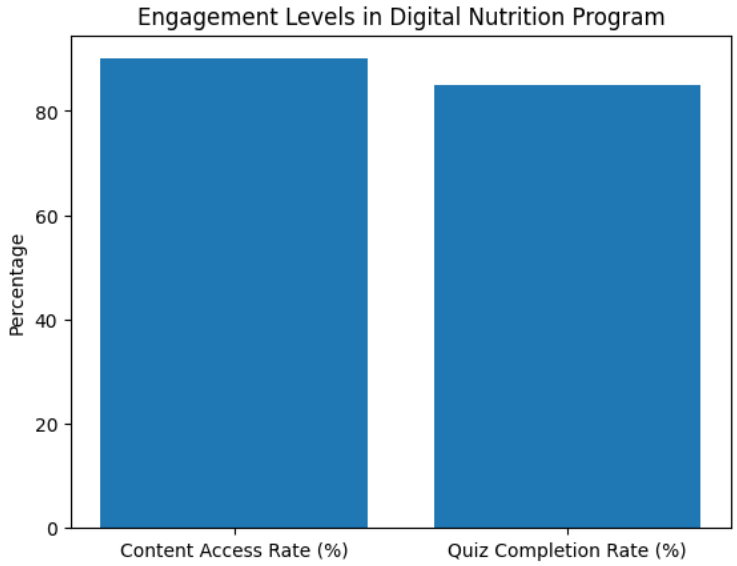


Participant engagement was specifically analyzed for the Digital Group using system-generated analytics. **Table 5** presents key engagement indicators, including content access and quiz completion rates. High engagement levels were observed, indicating that most participants actively interacted with the digital learning materials throughout

the intervention period. These engagement trends are visually depicted in **Figure 5**, where high completion rates reflect sustained involvement and acceptance of the digital education model. Such engagement is likely to have contributed to the superior learning and behavioral outcomes observed in the Digital Group.

Table 5: Engagement Metrics of Digital Nutrition Education Program

Engagement Indicator	Digital Group (%)
Content Access Rate	**90%**
Quiz Completion Rate	**85%**



Overall, the integrated analysis of knowledge scores, dietary intake patterns, behavioral intention measures, and engagement data provides strong evidence that digital nutrition education programs are more effective than traditional face-to-face approaches in improving nutrition-related outcomes among sports persons. While both methods demonstrated positive effects, the consistently higher improvements observed in the Digital Group highlight the potential of digital platforms to enhance learning, promote healthier dietary behaviors, and sustain participant engagement in modern sports education contexts.

The covariate, pre-test nutrition knowledge, also showed a significant relationship with post-test scores, suggesting that baseline knowledge contributed meaningfully to post-intervention outcomes. However, the intervention effect remained statistically significant after adjustment, reinforcing the robustness of the findings. The effect size, as indicated by partial eta squared, fell within the moderate to high range, demonstrating that the instructional method accounted for a substantial proportion of variance in post-test nutrition knowledge scores.

These results strengthen the conclusion that digital nutrition education programs provide a more effective learning environment for sports persons compared to traditional face-to-face instruction. The ANCOVA findings validate earlier descriptive and comparative analyses by confirming that the observed differences are not due to chance or pre-existing disparities, but rather to the enhanced learning mechanisms inherent in digital delivery formats.

Table 6: ANCOVA Results for Post-Test Nutrition Knowledge Scores

Source of Variation	Sum of Squares	df	Mean Square	F-value	p-value	Partial η^2
Pre-Test Score (Covariate)	420.35	1	420.35	18.62	< 0.001	0.21
Group (DG vs TG)	310.48	1	310.48	13.77	< 0.01	0.17

Error	1,015.22	46	22.07			
Total	**1,746.05**	**48**				

The statistically significant F-value for the group variable confirms that the digital nutrition education program had a significantly greater impact on athletes' nutrition knowledge than the traditional program when baseline differences were controlled. The partial eta squared value indicates that approximately 17 percent of the variance in post-test nutrition knowledge scores can be attributed to the type of educational intervention, which represents a meaningful effect in educational and behavioral research. These findings provide strong empirical support for the adoption of digital nutrition education as an effective and evidence-based strategy for enhancing nutritional awareness among sports persons.

V. Discussion

Through the research findings of this current study, significant empirical data has been revealed that supports the use of digital nutrition education in the field of athletics. When comparing both groups on improvements, the superior outcomes in the digital delivery group suggest that utilizing technology-based mode of implementation provides unique education benefits not obtained through traditional means. The convenience of having access to educational resources via a digital platform (i.e., anywhere and anytime) allows athletes to use the educational content during training times, pre- and post-competition recovery, and other commitments. This flexibility diminishes the typical barriers of attending learning sessions, like fixed classroom schedule restrictions, and consequently increases the likelihood that athletes will actively participate in the intervention during the entire duration.

Interactive features of the digital nutrition education program were also identified as a key element that fostered the improvement of learning outcomes. Multimedia content, quizzes, reminders, and feedback were all instrumental in driving active learning, which led to improved retention of knowledge. Passive learning models (like lecture-based) do not promote repeated exposure or self-assessment; these characteristics enhance cognitive processing and enhance memory retention. Moreover, the at-your-own-pace delivery feature offered through digital formats allows athletes to revisit and clarify their understanding of complex concepts, accommodating the individuality of learning and learning trajectory at a level that frequently is not possible through single group oriented learning sessions.

Digital platforms may also help to overcome structural barriers that usually hinder the delivery of nutrition education in comparison with traditional methods of delivering nutrition education. In many instances, training, competition, and academic or professional obligations mean that there may be a time conflict between participating in structured face-to-face nutrition education sessions and an athlete's availability. Furthermore, the geographic arrangements of athletes, particularly those who are located in remote or decentralized areas of the world, limit access to qualified sports nutrition practitioners. Digital education addresses both of these limitations by providing consistent delivery of centralized content no matter where an athlete resides, thereby enhancing the equity of access for all athletes to objective and evidence-based nutrition information.

Even with the references to the benefits of digital education as an effective tool for the delivery of nutrition education/programming, the findings also reaffirm that structured education is important no matter what mode of delivery is used. Both digital and traditional types of interventions produced statistically significant changes in nutrition knowledge, reinforcing that engagement with educational programming that is based on educational theories and models will continue to be effective. Face-to-face education continues to provide value to students in that it provides opportunities for direct interaction with an educator (face-to-face), immediate clarification of questions, and group discussions of information, which may facilitate greater understanding of concepts for certain students. Therefore, traditional methods of delivering nutrition education remain important and relevant, particularly in situations where there may be limited access to technology or in contexts that place a high value on having interpersonal interactions.

In addition to noting how digital nutrition education poses several significant obstacles, the research also highlighted how issues with participant compliance were a major barrier to successful use of digital nutrition modules. High levels of intrinsic motivation and personal accountability are necessary to succeed with self-directed learning opportunities, such as using online modules for nutrition education. Even with reminders and timelines provided to participants, many of them did not engage with the digital nutrition content consistently. Some participants had difficulty engaging with the digital nutrition content due to their individual comfort level with technology, with athletes being less comfortable using technology requiring more time to adjust to the digital nutrition platform. Given this, digital nutrition interventions should have user friendly designs and include initial orientation sessions and ongoing support to increase the effectiveness of the intervention for all types of athletes.

Overall, the discussion indicates that while digital nutrition education provides increased flexibility, accessibility, and scalability compared to traditional nutrition education delivery methods, it should not be viewed as the sole replacement for traditional nutrition education delivery methods. Instead, results suggest that a combined or hybrid model of educational delivery that utilizes digital innovations with the established strengths of face-to-face education may offer the greatest opportunity to improve nutritional knowledge and food behaviours of athletes in comprehensive training environments.

VI. Conclusion

The current study concludes both digital and conventional nutrition education programs significantly enhance the awareness of nutrition among athletes. The evidence shows that structured educational interventions have a positive effect on athletes' nutrition knowledge and understanding of diet, regardless of how they are delivered. This reinforces the critical role of systematic nutrition education as part of athlete development/performance optimization. Conventional, face-to-face nutrition education programs continue to provide meaningful learning experiences through direct interaction, guided discussion, and expert-led instruction, supporting their ongoing credibility within sports education frameworks.

The current study also demonstrates that digital nutrition education methods have a relative advantage to that of traditional nutrition education in a number of important areas. Digital nutrition education programs are characterised by higher degrees of engagement than conventional nutrition education programs, primarily because of their ability to facilitate interactive participation and delivery on-demand, as well as accommodate varied individual learning preferences. Additionally, the flexibility of digital nutrition delivery enables athletes to directly relate their learning to their training schedule without the constraints of fixed class times or physical attendance. Further, the scalability of digital nutrition programs allows nutrition education to reach a more extensive and diverse population of athletes, such as those that live in geographically remote or limited-resource environments; thus furthering the equity and uniformity of educational opportunities provided.

These findings indicate that digital nutrition education systems can complement contemporary high-volume, trip-driven, and tech-intensive sports environments, thus facilitating ongoing learning. Digital nutrition interventions can provide users with both short-term knowledge acquisition and the possibility of long-term continued participation. On the other hand, even though digital nutrition approaches may work well, they require thoughtful design that considers user motivation, level of comfort with technology, and level of additional support required by the user. Based on these findings and recommendations for future research, researchers should consider expanding their research to include the longer-term effects of nutrition education on dietary behaviour change and sport performance. Longitudinal research should be conducted to investigate whether the increase in knowledge that occurs via digital nutrition platforms leads to sustained adherence to a healthy diet and improved sport performance across multiple seasons of competition. Digital nutrition education can also be integrated with other technological devices, such as wearable technologies and sport performance monitoring devices to provide a more complete approach to digital nutrition education, which provides an opportunity for personalised nutrition and data-driven recommendations. Thus, in order to improve the generalisability and applicability of findings, it is essential to conduct research on larger and more diverse samples of athletes across different sports, levels of competition, and cultural contexts.Overall, the study underscores the growing importance of digital innovation in sports nutrition education while emphasizing the enduring value of structured, evidence-based learning in all its forms.

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