Title

Evaluation of Nutrition Knowledge in Elite and Sub-Elite Gaelic Football Players

Running Head

Nutrition Knowledge of Gaelic Football Players

Authors

Michèle Renard[1,2], Ana Anton-Solanas[2], David Kelly[1], Ciarán Ó Catháin[1]

[1] Department of Sport and Health Sciences, Athlone Institute of Technology, Athlone Ireland.

[2] School of Sport Health and Applied Sciences, St Mary's University, Twickenham, UK.

Corresponding author

Mr Michèle Renard

Department of Sport and Health Sciences,
Athlone Institute of Technology,
Athlone, Co. Westmeath,
Ireland
Telephone: +353 (0) 830390623
E-mail: m.renard@research@ait.ie

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ABSTRACT:

Nutrition knowledge is a key factor for consideration when evaluating the dietary intake of athletes. Positive associations have been established between higher nutrition knowledge and improved quality of dietary intake. Given the negative impact poor nutrition can have on performance and training adaptation, further investigation into athletes' nutrition knowledge is warranted. Gaelic football is a field-based invasion team sport and players represent a unique sporting population due to their quasi-professional status. Inadequacies in players dietary intake have been observed, however no assessment of nutrition knowledge has been reported. This study examined players knowledge and compared results by playing level, education level, and history of nutrition education. An online survey was disseminated to a sample of male Gaelic football players (n = 152, mean age = 24.5 $\pm$ 5.9). This included 68 club (sub-elite) and 84 inter-county players (elite). Total score was 44.3 $\pm$ 12.7%, classified as "poor" and lower than previous findings from similar team sports. Significance was set at $p<0.05$ for all tests. There were no differences between playing level, however when grouped by education level those with master's degree scored higher by 9.9% in comparison to leaving certificate (upper secondary) ($P= 0.009$, $d = .805$). Those with previous nutrition education also demonstrated higher scores by 12.5% ($P<.001$, $d = 1.096$). The evidence presented highlights that Gaelic football players may benefit from evidence-based nutrition education interventions. Future research should consider assessment of both nutrition knowledge and dietary intake to examine any direct influence upon behaviour and subsequently sporting performance.

KEY WORDS:

Questionnaire, survey, assessment, education, team sport, dietary behaviour

INTRODUCTION:

Optimal nutritional intake is essential for maximizing athletic performance (32). Despite this, athletes' diets have repeatedly been identified as inadequate, demonstrating insufficient energy intake to support training (22) and competition (40), consistent failure to meet carbohydrate recommendations (4, 9), and excessive consumption of protein and fat (14, 29). Multiple factors are thought to influence dietary intake including cultural beliefs, taste, food preference, convenience, availability, appetite and attitude towards nutrition, as well as nutritional knowledge (8, 19). Of these factors, nutrition knowledge has been identified as one of the most pivotal, due to its modifiable nature (35), capacity to drive the adoption of healthier food habits (49), and improve adherence to nutritional recommendations (48). Nutrition knowledge can also be measured easily through the use of a validated questionnaire (42, 43).

Previous systematic reviews of athletes' nutrition knowledge and its impact on dietary intake have identified significant, but weak positive associations ($r = 0.05 – 0.261$) (19, 36, 37). However, the broad range of these associations may be influenced by the heterogeneity of methods used. For example, there is a large discrepancy in question type and format across measures to assess nutrition knowledge (41), as well as a large variance in tools used to assess dietary intake, such as food frequency questionnaires, 24 hour recalls and dietary records (37).

Factors such as history of nutrition education, a higher level of general education (6, 16, 21, 23, 50). and a higher level of athletic performance (18), have been associated with higher nutrition knowledge previously. Despite this, a recent review of studies

investigating nutrition knowledge, identified that only 11 of 29 articles explored the difference in knowledge between demographic characteristics (37). As the difference in nutrition knowledge between demographic groups may mediate the relationship between nutrition knowledge and dietary behaviour, further investigation is warranted. Such analysis would also differentiate the nutrition education needs amongst groups and inform whether or not the content of a future educational intervention should be stratified based on any differences observed.

As highlighted, the relationship between nutrition knowledge and improvements in dietary behaviour is complex. The literature does however indicate that practical improvements in dietary intake can be achieved through increases in nutrition knowledge (46). A dietician lead nutritional education intervention among volleyball players, resulted in improvements in nutrition knowledge score by 12.4% which corresponded with increased intake of total energy (+24%), carbohydrate (+36%) and protein (+22%), closer to recommended values (46). When nutrition knowledge has been measured previously, associations between higher nutrition knowledge scores and the consumption of more carbohydrate-rich foods including cereals, fruits, and vegetables, have been identified among elite rugby players (3). As increases in carbohydrate intake have been previously shown to improve performance in team sport athletes (2, 5), improvements in nutrition knowledge could serve as a driver for improvements in the quality of dietary intake and subsequently performance. Therefore, developing targeted education plans to increase nutrition knowledge may be a practical method for improving dietary intake, which could benefit a broad range of groups that currently fail to meet nutritional recommendations (20).

Gaelic football holds the highest participation rate of all field-based invasion team sports in Ireland (30). The sport is intermittent in nature, and is contested by two teams of 15 players, on a pitch 130-145 m long and 80-90 m wide (7). For club level players (sub-elite) each half of the game is 30 minutes in duration, with inter-county players (elite) contesting 35-minute halves (24, 45). The sport has retained amateur status since its initial inception, however, players conduct rigorous and systematic training similar to other professional sports (30, 38). Gaelic football players dietary intake has been identified as inadequate to meet recommendations, with average energy deficits of 12.3% per day (27), carbohydrate intakes of 3.4-3.7g.kg.day^{-1} per day (11, 26, 27) lower than minimum recommendations for 5g.kg.day^{-1}, protein intakes of 1.9-2.1g.kg.day^{-1} (11, 26, 27) towards the higher end of recommendations of 1.2-2.0g.kg.day^{-1} (39) and fat intakes of 31-37.5% of total daily energy intake (TDEI) also at the higher of end recommendations for 20-35% TDEI (39). Based on such assessment, there has been a call for educational interventions for Gaelic football athletes in a bid to improve their current nutritional strategies (26, 27). For effective interventions to be designed and implemented at an appropriate level, initial assessment of the populations current knowledge is required.

With this in mind, this study's primary aim was to investigate the nutrition knowledge of Gaelic football players, and to compare nutrition knowledge scores based on categories of playing level, highest level of education and history of formal nutrition education. It was hypothesised that players would display overall poor nutrition knowledge, and players competing at elite levels (intercounty), and those with higher levels of education and history of formal nutrition education, would score higher on average.

METHODS:

Experimental Approach to the Problem:

The abridged nutrition for sport knowledge questionnaire (A-NSKQ) (43) was utilised to assess the nutrition knowledge of players. The questionnaire consists of 37 questions in total, 17 of which focus on the assessment of nutrition knowledge for general health and the remaining 20 assess knowledge specific to sports nutrition (43). This questionnaire was selected specifically, due to its previous use among team sport athletes (43, 44) and its extensive level of validation in comparison to other tools available including assessment of content/construct validity, test re-test reliability and validation against the Rasch model (43). The abridged version of the questionnaire was used to facilitate shorter completion times, and thus higher completion rates (43). This is in line with previous research where shorter completion times increase completion rate by 21.4% (15).

Independent variables of playing level, highest level of education and history of formal nutrition education were investigated as these have previously been identified to influence nutrition knowledge (17, 23, 50).

Subjects:

Male Gaelic football players (n = 152, mean age = 24.5 $\pm$ 5.9 years), competing at both club level (sub-elite) (n = 68, age = 26.5 $\pm$ 7.0 years) and inter-county level (elite)

(n= 84, age = 22.9 ± 4.2 years) were recruited. Players were recruited across different levels of competition to allow for comparisons of nutrition knowledge between groups (36). In addition to playing level, these groups included previous formal nutrition education (yes = 27, no = 125, defined by a recognised qualification and/or credited nutrition module), age (18-24 = 90, 25-30 = 35, ≥31 = 27), and general education (junior certificate = 5, leaving certificate = 65, higher certificate = 8, bachelor's degree = 28, honour's degree = 25, master's degree = 25). Participants provided informed consent, ethical approval was obtained from the review board at St Mary's University, Twickenham (UK), and all proceedings were in accordance with the declaration of Helsinki.

Procedures:

Team managers were approached for the dissemination of the A-NSKQ questionnaire, and it was also shared online. Due to this response rates were not calculated as the survey was distributed via multiple online media platforms, or second parities where total exposure was unknown. All questionnaires were completed digitally using Online Surveys (Jisc, UK). Participants were unable to submit the questionnaire until all questions were answered, ensuring only fully completed questionnaires were obtained. Online delivery was chosen as it has previously been shown to facilitate greater access to participants, and enhance participant experience in comparison to paper-based methods (47). Recruitment and data collection took place between March 2019 and January 2020. Performance within the A-NSKQ was assessed using the following scoring system: "poor" (0-49%), "average" (50-65%), "good" (66-75%) and "excellent" knowledge (76-100%) (42). Scores were presented as total score from

37 questions, general nutrition knowledge (GNK) sub-total from the 17 questions that focus on nutrition for general health, and sports nutrition knowledge (SNK) sub-total from the 20 questions that focus on sport-specific concepts.

Statistical Analyses:

Statistical analysis was performed using IBM SPSS statistical software for Mac Version 24.0 (IBM corporation, Armonk, New York, United States). Data was reported as mean and standard deviations. Normality of test scores was assessed using Shapiro-Wilk's test, and homogeneity of variances was assessed using Levene's test. Difference in test scores between groups of playing level and groups of nutrition education was analysed using independent sample T-tests. Effect size for the T-tests were reported as Cohen's d, and interpreted as small (d = 0.2), medium (d = 0.5) and large (d = 0.8) (12). Multiple ANOVA's were used to assess differences in knowledge scores based on both age and general education (junior certificate = 5, leaving certificate = 65, higher certificate = 8, bachelor's degree = 28, honour's degree = 25, master's degree = 25) categories. Post-hoc analysis was performed using Tukey's post hoc test. The preferred effect size for ANOVA of partial eta squared (η^2) was reported, this was interpreted as small (η^2 = 0.010), medium (η^2 = 0.060) and large (η^2 = .140), (12). Multiple linear regression was used to explore factors that predict nutrition knowledge, with assumptions of independence of residuals, collective linear relationship to the dependent variable, homoscedasticity, multicollinearity, high leverage/influential points and normal distribution assessed. Effect size for the multiple linear regression was reported as r^2, and interpreted as small (r^2 = 0.1-0.3), medium

(r^2 = 0.3-0.5) and large (r^2 = >0.5) (12). Alpha was set at $p<0.05$ for all tests, with confidence intervals reported at the level of 95%.

RESULTS:

Overall knowledge scores:

The mean total score was 44.3 ± 12.7%, classified as "poor". Full characteristics and scores of the participants who completed the A-NSKQ are outlined in table 1 below.

(*Table 1 about here)

Comparison by factors:

An independent-sample t-test revealed no significant differences between elite and sub elite players for A-NSKQ (t(150) = -0.033, p = 0.974), GNK (t(150) = 1.244, p = 0.215) and SNK (t(150) = -1.269, p = 0.206) scores.

(*Figure 1 about here)

ANOVA analyses indicated that total A-NSKQ and SNK, displayed significant differences for highest level of education (A-NSKQ: F (5, 145) = 2.861, p = 0.017, η^2 = 0.090; SNK: F(5, 145) = 3.380, p = 0.006, η^2 = 0.104), whereas GNK did not (p = 0.082, η^2 = 0.064). Tukey post hoc analysis revealed that the significant differences for education level were between leaving certificate and master's degree for total A-NSKQ (3.66, 95% CI 0.620 to 6.690, p = 0.009, d = 0.805), and for SNK (1.97, 95%

CI 0.229 to 3.716, p = 0.017, d = 0.756). Furthermore, SNK also displayed differences between higher certificate and master's degree (3.66, 95% CI (0.646 to 6.664), p = 0.008, d = 1.345).

(*Figure 2 about here)

ANOVA analyses indicated that Total A-NSKQ displayed significant differences between age groups (F (2, 149) = 3.051, p = 0.050, η^2 = 0.039) whereas GNK (p = 0.091, η^2 = 0.032) and SNK (p = 0.121, η^2 = 0.028) did not. Tukey post hoc analysis revealed that the significant difference for age was between 18-24 years and 25-30 years (2.24, 95% CI 0.057 to 4.416, p = 0.043, d = 0.485).

(*Figure 3 about here)

A t-test indicated that those with formal nutrition education scored higher, (54.6%, 20.19 ± 4.00) than those without, (42.1%,15.56 ± 4.42), (4.63, 95% CI 2.802 to 6.449, t(150) = 5.012, p = <0.001, d = 1.096). The differences in sub-total scores were also statistically significant, GNK (p = <0.001, r^2 = 0.124) and SNK (p = <0.001, d = 0.852).

Regression model:

An initial multiple regression was performed in attempt to explain the variance in total A-NSKQ score from nutrition education, highest level of education, playing level, and age. Variables of playing level and age group did not contribute significantly to the model, p > .05, and were therefore removed. Therefore, a multiple regression model

including nutrition education and highest level of education only, explained 17.3% of the variance in A-NSKQ score, F (2, 148) = 16.667, $p < .001$, adj. $R^2 = .173$. Both variables added statistically significantly to the model, $p < .05$. Regression coefficients and standard errors can be found in Table 2 (below).

(*Table 2 about here)

The Equation (1) for the regression model is: $X = 21.597 + (0.685 \times Y) – (4.188 \times Z)$, where, *X* represents predicted total A-NSKQ score, *Y* represents highest level of education (Junior Certificate = 1.00, Leaving Certificate = 2.00, Higher Certificate = 3.00, Bachelor's Degree = 4.00, Honours Degree = 5.00, Master's Degree = 6.00) and *Z* represents previous nutrition education (With = 1.00, Without = 2.00)

DISCUSSION:

This study aimed to investigate the nutrition knowledge of Gaelic football players and to compare nutrition knowledge scores based on categories of playing level, highest level of education and history of formal nutrition education.

The Gaelic football sample's mean A-NSKQ score was 44.3 ± 12.7% and classified as "poor". This is similar to the scores from female Gaelic games players (46%, n = 328) (31) and Australian football players (47%, n= 177) (43). GNK (50.2%) and SNK (39.2) were classified as average and poor respectively. Trackman et al. (2018) reported GNK scores of 59% and SNK scores of 35%, showing that Gaelic football players scored lower on aspects of knowledge related to general health. Wider comparisons

312 rank the nutrition knowledge of Gaelic football players as poor in comparison to
313 professional rugby players (73%) (3), long-distance runners (64%) (16) and soccer
314 players (56%) (14).
315
316 The poor sports nutrition knowledge presented, may negatively influence Gaelic
317 footballers' current dietary practices. Gaelic footballers' dietary patterns have been
318 shown to be deficient in energy intake with an average deficit of 12.3% per day (27),
319 and low in carbohydrate with mean intakes of 3.4-3.7g.kg.day^{-1} per day recorded
320 within pre-season, game preparation and recovery periods (11, 26, 27). These
321 carbohydrate intakes fail to meet guidelines of 5-7g.kg.day^{-1} to support a moderate
322 exercise programme (10, 39) and may partly be explained by consumptions of fat (31-
323 37.5% TDEI) and protein (1.9-2.1g.kg.day^{-1}) (11, 26, 27) at the higher end of
324 recommendations of 20-35% TDEI and 1.2-2.0g.kg.day^{-1} per day, respectively (39).
325 Similar distributions of fat and protein intake have previously shown to compromise
326 the carbohydrate intake of male soccer players (34). Previous investigations in other
327 team sport athletes have highlighted that those with poor nutrition knowledge also
328 failed to meet carbohydrate recommendations (13, 25). Male and female Australian
329 rules football players with poor NK scores have shown low carbohydrate intakes
330 ranging from 2.8g-3.2g/kg per day (13, 25). Rugby players with nutrition knowledge
331 scores classified as "good" consumed carbohydrate-rich foods more frequently than
332 players with nutrition knowledge scores classified as "poor" (3), with 21.8% more
333 reporting consumption of cereals "often" and 21.8% and 40.9% more reporting the
334 consumption of fruits and vegetables "occasionally" (3). Based on this evidence,
335 higher nutrition knowledge scores in Gaelic football may result in a greater intake of
336 carbohydrate and improved dietary behaviour.

Nutrition education interventions have displayed positive improvements in dietary intake in numerous team sports (1, 33, 46). Volleyball players have displayed increases in nutrition knowledge scores (12.4%) total energy intake (+24%), CHO intake (+36%) and protein intake (+22%) (46) following a nutrition education intervention. Collegiate soccer players and swimmers displayed increases in nutrition knowledge, with reported improvements in dietary intake, however specific data was not presented to identify what the improvements were or where they occurred (1). Baseball players have also displayed increased energy intake (+17%) to meet energy demands as a result of a nutrition knowledge intervention (33). The above interventions varied in duration between 10-12 weeks (1, 33) and a 4-month off-season period (46). Their design consisted of either, four dietician lead individualised dietary education sessions (46), a single 90 minute group information session with tri-weekly reinforcement sessions (33) or a curriculum of 8 1-hour educational sessions (1). This highlights that a variety of protocols with a range of resources used, lead to improvements in nutrition knowledge and dietary intake. Gaelic football coaches and support teams may therefore consider the use and design of multiple strategies depending on the resources at their disposal.

There were no significant differences between Total A-NSKQ, GNK or SNK scores when compared by playing level. This is consistent with that observed in Australian football and Soccer (14, 25, 43). This may indicate that sub-elite and elite players have similar access to nutritional support (25). However, previous research has shown a lack of difference in nutrition knowledge between those with and without access to a dietician (44). This contradictory finding may be explained by assessing the

362 engagement of players with the dietary support available. It is therefore important that
363 future work investigates whether sub-elite or elite players have access to a nutritionist
364 in addition to the frequency of such support and whether or not economic/time
365 constraints limit their engagement with such services (25). This is of particular
366 relevance to elite Gaelic football players given the unique amateur status of the sport,
367 which often requires players to balance full-time jobs and extensive travel with a
368 training regimen representative of the demands of a professional athlete (7). With this
369 in mind, variation in players social economic status may dictate the level of
370 engagement with nutritional support, thus having an influence on nutrition knowledge.
371 Higher socioeconomic status has been associated with higher nutrition knowledge
372 previously (28), and future research should explore this in Gaelic football players.
373
374 Highest level of education, and previous history of formal nutrition education were
375 identified as influential factors on nutrition knowledge scores. The largest significant
376 differences for Total A-NSKQ score were apparent between comparison of higher
377 certificate and master's degree total A-NSKQ scores (9.9%) and between
378 comparisons of those with formal nutrition education and without (12.5%). Similar
379 observations have also been identified amongst varsity athletics athletes, collegiate
380 basketball and soccer players, as well elite and sub-elite Australian football players (6,
381 23, 43, 50). The multiple regression model presented, accounts for 17.3% of the
382 variance in total A-NSKQ from only the variables of nutrition education and highest
383 level of education, emphasising the importance that education has on knowledge
384 scores, and potentially on behaviour. Therefore, it appears these variables may be
385 critical when attempting to seek increases in nutrition knowledge. The large difference
386 in score between those with previous nutrition education (54.6%) and without (42.1%),

reinforces the requirement for evidence-based nutrition education interventions. Furthermore, future research should explore participants preferences on how nutritional education advice is delivered, so the protocols designed can be of maximum benefit (44).

This study's limitations must also be acknowledged. Participants were instructed to complete the questionnaire honestly in respect of the demographic data captured and independently in respect of nutrition knowledge assessment, without support or access to further resources at the time of completion. However due to the nature of the online distribution, whether participants followed such instructions is uncertain. Theoretically participants could have lied about their player status and checked their answers at the time of completion, however the poor overall scores identified and the time investment in completing the survey, suggests both cases were unlikely. Furthermore, the assessment of knowledge alone does not necessarily predict an athlete's behaviour, yet it is an important factor that must be considered, given the evidence of its positive influence (46) . It is important to address the type of nutrition knowledge assessed by the A-NSKQ. Large focus is given to the assessment of participants declarative knowledge, such as specific macronutrient recommendations. It is possible that nutrition strategies focus more on aspects of procedural knowledge such as such as food selection, recipe planning and meal preparation skills (44). This could provide partial explanation for the poor understanding of nutrition knowledge displayed by a majority of athletes (41). An athlete's level of procedural knowledge is also likely to provide a crucial link for the translation of improvements in declarative nutrition knowledge to improvements in dietary behaviour (49). Future research should therefore aim to account for participants procedural knowledge and future nutrition

412 education-based interventions may prove more effective if this is assessed and
413 supported.
414
415 **PRACTICAL APPLICATIONS:**
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417 Gaelic football coaches and support teams should focus on strategies to improve the
418 nutrition knowledge of players. Assessing baseline nutrition knowledge using tools
419 such as the A-NSKQ may help to tailor education to athlete's needs. Interventions may
420 also be stratified based on the athlete's highest level of education and/or history of
421 previous formal nutrition education. Seeking increases in nutrition knowledge may
422 lead to improvements in dietary behaviour and subsequently match play performance
423 and training adaptation.
424
425 In conclusion, the nutrition knowledge of Gaelic football players is classified as poor,
426 which if improved may lead to beneficial changes in dietary behaviour as observed
427 previously in volleyball players (46). In light of the results, considerable effort should
428 be given to enhancing Gaelic football players general nutrition education for the
429 purpose of health and wellbeing, before sport-specific concepts for the enhancement
430 of performance are considered. Future investigation into nutrition knowledge in
431 combination with dietary intake assessment within the population will allow for greater
432 inferences to be established with regards to the extent of such a relationship. Given
433 the significant influence general education has on nutrition knowledge, future
434 interventions may benefit from a stratified approach whereby education intervention
435 protocols are tailored based on nutrition knowledge scores.
436

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Table 1

Participant Scores

Group	*(n)*	*Total*	*(%)*	*GNK*	*(%)*	*SNK*	*(%)*
Total Sample:	152	16.4	44.3	8.5	50.2	7.8	39.2
Level of GAA played:							
Club (sub-elite)	68	16.4	44.2	8.8	52.0	8.8	44.2
County (elite)	84	16.4	44.3	8.3	48.8	8.3	41.5
Nutrition Support:							
Information Only	40	16.9	45.5	8.6	50.6	8.3	41.3
Info & Nutritionist	69	15.8	42.6	8.1	47.8	7.6	38.2
None	43	16.9	45.8	9.1	53.8	7.8	39.0
Highest Level of Education:							
Junior Certificate	5	16.6	44.9	8.4	49.4	8.2	41.0
Leaving Certificate	65	15.2	41.0	7.9	46.3	7.3	36.5
Higher Certificate	8	14.5	39.2	8.9	52.2	5.6	28.1
Bachelor's Degree	28	17.1	46.1	9.2	54.0	7.9	39.5
Honours Degree	20	16.4	44.2	8.3	48.5	8.1	40.5
Master's Degree	25	18.8	50.9	9.6	56.2	9.3	46.4
Doctorate Degree	1	28.0	75.7	12.0	70.6	16.0	80.0
Age:							
18-24	90	15.7	42.4	8.2	48.0	7.5	37.6
25-30	35	17.9	48.4	9.3	54.6	8.6	43.1
≥31	27	16.7	45.2	8.8	51.9	7.9	39.6
Formal Nutrition Education:							
Yes	27	20.2	54.6	10.4	61.4	9.7	48.7
No	125	15.6	42.1	8.1	47.8	7.4	37.2

Note: Total = overall A-NSKQ score, GNK = general nutrition knowledge sub-score, SNK = sports nutrition knowledge sub-score

Table 2

Summary of Multiple Regression Analysis

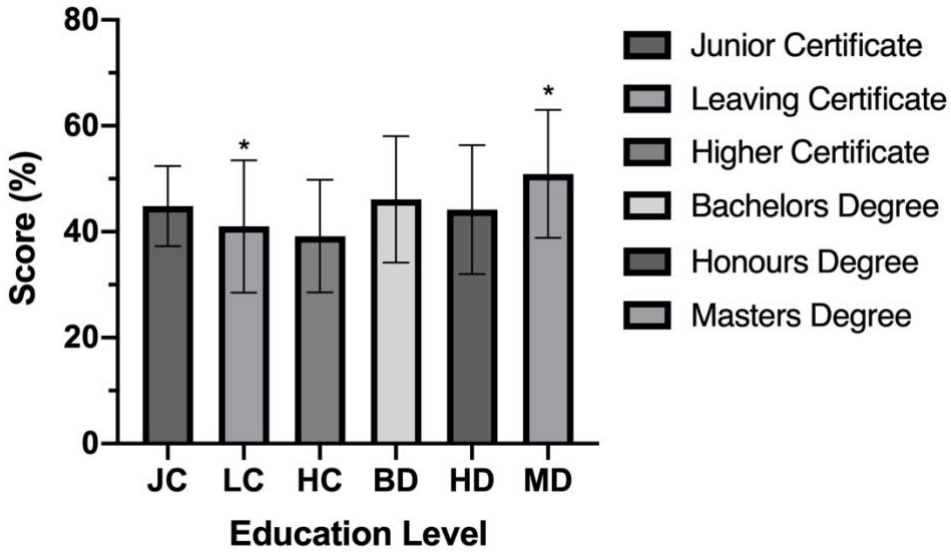
Variable	*B*	SE_B	β
Intercept:	21.597	1.869	
Highest Level of Education	0.685	0.213	0.239*
Formal Nutrition Education or Not	-4.188	0.903	-0.345*

**Note: *** P < .05 B = unstandardized regression coefficient; SE_B = standard error of the coefficient; β = standardized coefficient

Figure 1. A-NSKQ total score compared by highest level of education obtained. Data are mean ± SD. * Statistically significant difference between leaving certificate and master's degree (p = 0.009, d = 0.805).

Figure 2: A-NSKQ total score compared by age group**.** Data are mean ± SD. * Statistically significant difference between 18-24 and 25-30 (p = 0.043, d = 0.485).

Figure 3: A-NSKQ total score compared by formal nutrition education or not. Data are mean ± SD. * Statistically significant difference between those with formal nutrition education and those with not (p = <0.001, d = 1.096).



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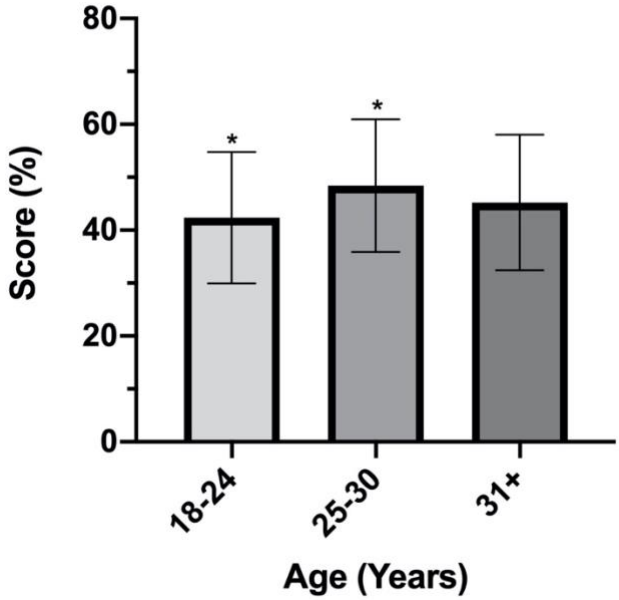
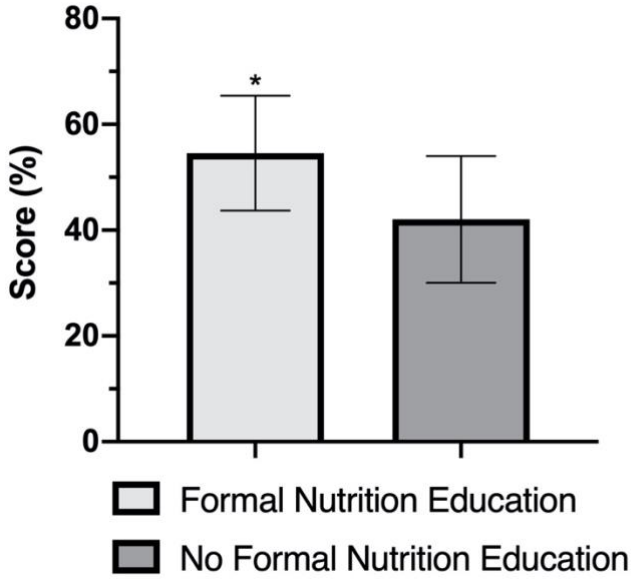

80
60
40
20
0
Score (%)
*
*
18-24
25-30
31+
Age (Years)


80
60
40
20
0
Score (%)
*
Formal Nutrition Education
No Formal Nutrition Education

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