Determining the Relative Validity and Reproducibility of a Food Frequency Questionnaire to Assess Food Group Intake in High Performing Athletes

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Abstract

**Background:** Optimal nutrition is essential for high performing athletes in order to train effectively, optimise recovery and improve their performance. Given the differences in dietary requirements and practices that exist between athletes and the general population, dietary assessment tools designed specifically for athletes are required. Food frequency questionnaires (FFQs) are commonly used to assess habitual dietary intake as they are inexpensive, quick and easy to administer. Currently there are no athlete-specific, up-to-date, valid and reproducible FFQs to assess food group intake of athletes. This study aims to determine the relative validity and reproducibility of an athlete-specific FFQ against an estimated four day food record (4DFR) to assess food group intake in high performing athletes.

**Methods:** Data from 66 athletes (24 males, 42 females) representing their main sport at regional level or higher and aged 16 years and over, was collected as part of a validation study in 2016. Athletes completed the athlete-specific FFQ at baseline (FFQ1) and four weeks later (FFQ2) to assess reproducibility. An estimated 4DFR was completed between these assessments to determine the relative validity of the FFQ1. Foods appearing in the 4DFR were classified into the same 129 food groups as the FFQ, and then further classified into 28 food groups in gram amounts. Agreement between the two methods for intake of food group and core food group intake was assessed using Wilcoxon signed rank tests, Spearman’s correlation coefficients, cross classification with tertiles, the weighted kappa statistic and Bland-Altman analysis.

**Results:** The FFQ overestimated intake for 17 of 28 food groups compared with the 4DFR (p<0.05). Correlations ranged from 0.11 (processed foods) to 0.78 (tea, coffee & hot chocolate), with a mean of 0.41. Correct classification of food groups into the same tertile ranged from 35.4% (starchy vegetables) to 55.5% (fats & oils). Misclassification into the opposite tertile ranged from 4.6% (legumes) to 15.4% (starchy vegetables; sauces & condiments). The weighted kappa demonstrated fair to moderate agreement (k=0.21-0.60) for food groups. Bland-Altman plots suggested that for most of food groups, the difference between FFQ1 and the 4DFR increased as the amount of each food group consumed increased. Intake from FFQ1 was significantly higher than from FFQ2 for 13 of 28 food
groups. All effect sizes were small (r=0.1). Reproducibility correlations ranged from 0.49 (potato chips; fats & oils) to 1.00 (tea, coffee & hot chocolate), with a mean of 0.65. For the 23 food groups classified into tertile, 20 had >50% of participants correctly classified, <10% grossly misclassified, and 20 demonstrated moderate to good agreement (k=0.61-0.80). The exceptions were dairy; fats & oils; and processed foods & drinks which presented fair agreement (k=0.21-0.40).

**Conclusions:** The FFQ showed reasonable validity and good reproducibility for assessing food group intake in high performance athletes in New Zealand. The FFQ could be used in future research as a convenient, cost-effective and simple way to obtain athletes’ food group intake, and identify those who could benefit from interventions to improve their nutritional adequacy and potentially their athletic performance.

**Keywords:** athlete; dietary assessment; questionnaire; validation; reproducibility
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Dedication

I would like to dedicate this thesis to my Oma, Julia Vonk. Sadly you passed away during the completion of this thesis, but I know you will be watching on from heaven proud of my achievements. You had the most beautiful soul and were always so supportive and encouraging of everything I did in life. You are dearly missed and will always hold a place in my heart.
# Table of Contents

Abstract.................................................................................................................................................. i  
Acknowledgements ..................................................................................................................................... iii  
Dedication ................................................................................................................................................ iv  
Table of Contents ..................................................................................................................................... v  
List of Tables ............................................................................................................................................. viii  
List of Figures .......................................................................................................................................... x  
Abbreviations List ....................................................................................................................................... xi  

## Chapter 1: Introduction ......................................................................................................................... 1  
1.1 Purpose of the study ............................................................................................................................. 5  
1.2 Aims, objectives & hypothesis ............................................................................................................ 5  
1.3 Structure of the thesis ......................................................................................................................... 5  
1.4 Researcher contributions .................................................................................................................... 6  

## Chapter 2: Literature Review ................................................................................................................ 7  
2.1 Introduction to the literature review .................................................................................................... 7  
2.2 Dietary intake and performance ........................................................................................................... 7  
2.3 Athlete dietary requirements ............................................................................................................... 9  
   Carbohydrates ..................................................................................................................................... 10  
   Protein .................................................................................................................................................. 11  
   Fat ...................................................................................................................................................... 11  
   Vitamins, minerals and antioxidants ..................................................................................................... 12  
   Fluid .................................................................................................................................................... 12  
2.4 Dietary assessment methods ............................................................................................................... 13  
   Prospective methods ............................................................................................................................. 14  
   Retrospective methods ......................................................................................................................... 15  
2.5 Selecting a dietary assessment method to be used in research ......................................................... 21  
2.6 Dietary assessment challenges in athletes .......................................................................................... 22  
2.7 Dietary assessment methods designed to assess dietary intake in athletes ...................................... 27  
2.8 Design and development of food frequency questionnaires ............................................................. 33  
2.9 Considerations when assessing the validity of food frequency questionnaires ................................ 35  
2.10 Considerations when assessing the reproducibility of food frequency questionnaires ...................... 37  
2.11 Statistical analysis of validity and reproducibility ........................................................................... 38  
2.12 Summary ......................................................................................................................................... 40
Chapter 3: Research Manuscript: Determining the relative validity and reproducibility of a food frequency questionnaire to assess intake of food groups in high performing athletes

3.1 Abstract .................................................................................................................. 41
3.2 Introduction ............................................................................................................. 43
3.3 Study Methodology ............................................................................................... 45
   Study design and participants ....................................................................................... 45
   Development of the food frequency questionnaire ....................................................... 45
   Study procedures .......................................................................................................... 46
   Data handling ............................................................................................................... 47
   Statistical analysis ....................................................................................................... 49
3.4 Results ................................................................................................................... 51
   3.4.1 Participant Characteristics ................................................................................ 51
   3.4.2 Validity of the FFQ .......................................................................................... 53
   3.4.3 Reproducibility of the FFQ .............................................................................. 62
3.5 Discussion ............................................................................................................... 70
   3.5.1 Validity for food groups .................................................................................... 70
   3.5.2 Reproducibility for food groups ...................................................................... 74
   3.5.3 Strengths and Limitations ............................................................................... 76
3.6 Conclusions ............................................................................................................ 78
3.7 Acknowledgements ............................................................................................... 79
3.8 Author Contributions ............................................................................................. 79
3.9 Conflicts of Interest ............................................................................................... 79

Chapter 4: Conclusions and Recommendations ............................................................ 80
4.1 Introduction ............................................................................................................. 80
4.2 Summary of findings .............................................................................................. 80
4.3 Strengths and Limitations ..................................................................................... 81
4.5 Research recommendations for further development and future research ............. 85
4.6 Conclusion .............................................................................................................. 86

Appendices .................................................................................................................. 88
Appendix A: Food frequency questionnaire .................................................................. 88
Appendix B: Standard order of procedures ................................................................ 129
Appendix C: Four day food record .............................................................................. 131
Appendix D: Condensed/amended food group list ...................................................... 148
Appendix E: Frequency Conversions .......................................................................... 153
Appendix F: Conversions into gram amounts .............................................................. 154
Appendix G: Assumptions and decision made for the food record ......................... 159
Appendix H: Supplementary results ................................................................. 165
Bland-Altman plots for validity ........................................................................ 165
Bland-Altman plots for reproducibility .............................................................. 169
Bland-Altman and linear regression tables ....................................................... 175
Mean results ..................................................................................................... 179

References ........................................................................................................ 183
List of Tables

Chapter 1: Introduction
Table 1.1 Researchers contributions to this study..........................................................................................6

Chapter 2: Literature Review
Table 2.1 Dietary assessment methods: procedures, advantages and disadvantages...............................19
Table 2.2 International dietary assessment validation studies in athletes..................................................29
Table 2.3 International dietary assessment reproducibility studies in athletes........................................32

Chapter 3: Research Manuscript
Table 3.1 Athlete characteristics...................................................................................................................51
Table 3.2 Comparisons of daily food group intakes in grams from FFQ1 and 4DFR (n=65).......................54
Table 3.3 Comparisons of daily core food group intakes in grams from FFQ1 and 4DFR (n=65)..............57
Table 3.4 Cross classification and weighted kappa for daily food group consumption between FFQ1 and 4DFR (n=65)........................................................................................................58
Table 3.5 Cross classification and weighted kappa for daily core food group consumption between FFQ1 and 4DFR (n=65)........................................................................................................60
Table 3.6 Comparisons of daily food group intakes in grams from FFQ1 and FFQ2 (n=65)....................62
Table 3.7 Comparisons of daily core food group intakes in grams from FFQ1 and FFQ2 (n=65)..............65
Table 3.8 Cross classification and weighted kappa for daily food group consumption between FFQ1 and FFQ2 (n=65)........................................................................................................67
Table 3.9 Cross classification and weighted kappa for daily core food group consumption between FFQ1 and FFQ2 (n=65)........................................................................................................68

Appendices
Table 1 Condensed/amended food group list...............................................................................................148
Table 2 Frequency conversions for the FFQ...............................................................................................153
Table 3 Weights (g) used for analysis of daily amounts used for each food item from FoodWorks9 for the FFQ and 4DFR........................................................................................................154
Table 4 Assumptions made when classifying food items from the 4DFR into food groups within the FFQ..............................................................................................................................159
Table 5 Assumptions made for amounts not reported in the 4DFR........................................................162
Table 6 Bland-Altman and linear regression analysis for daily food group intakes in gram from the FFQ1 and 4DFR (n=65) .........................................................................................................................175

Table 7 Bland-Altman and linear regression analysis for daily core food group intakes in gram from the FFQ1 and 4DFR (n=65) .........................................................................................................................176

Table 8 Bland-Altman and linear regression analysis for daily food group intakes in gram from the FFQ1 and FFQ2 (n=65) ........................................................................................................................176

Table 9 Bland-Altman and linear regression analysis for daily core food group intakes in gram from the FFQ1 and FFQ2 (n=65) ........................................................................................................................178

Table 10 Comparison of mean daily food group intakes in grams from the FFQ1 and 4DFR (n=65) ..................................................................................................................................................179

Table 11 Comparison of mean daily core food group intakes in grams from the FFQ1 and 4DFR (n=65) ..................................................................................................................................................180

Table 12 Comparison of mean daily food group intakes in grams from the FFQ1 and FFQ2 (n=65) ..................................................................................................................................................181

Table 13 Comparison of mean daily core food group intakes in grams from the FFQ1 and 4DFR (n=65) ..................................................................................................................................................182
List of Figures

Chapter 3: Research Manuscript

Figure 3.1 Bland-Altman plots of agreement for daily intake of (A) starchy foods (B) poultry (C) fats, oils, sauces & condiments and (D) processed foods & drinks between the FFQ1 and 4DFR.................................................................61

Figure 3.2 Bland-Altman plots of agreement for daily intake of (A) breakfast cereals (B) poultry (C) takeaway foods and (D) fats, oils, sauces & condiments between the FFQ1 and FFQ2........................................................................................................................................69/70

Appendices

Figure H1 Bland-Altman plots of agreement for daily intake of all food groups and core food groups......................................................................................................................................................165

Figure H2 Bland-Altman plots of agreement for daily intake of all food groups and core food groups......................................................................................................................................................169
## Abbreviations List

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>FFQ</td>
<td>Food frequency questionnaire</td>
</tr>
<tr>
<td>FFQ1</td>
<td>Food frequency questionnaire appointment one</td>
</tr>
<tr>
<td>FFQ2</td>
<td>Food frequency questionnaire appointment two</td>
</tr>
<tr>
<td>FR</td>
<td>Food record</td>
</tr>
<tr>
<td>4DFR</td>
<td>Four day food record</td>
</tr>
<tr>
<td>24-hr</td>
<td>Twenty-four hour</td>
</tr>
<tr>
<td>DLW</td>
<td>Doubly labelled water</td>
</tr>
<tr>
<td>NZ</td>
<td>New Zealand</td>
</tr>
<tr>
<td>NZWFFQ</td>
<td>New Zealand Women’s food frequency questionnaire</td>
</tr>
<tr>
<td>MUHNRC</td>
<td>Massey University Human Nutrition Research Centre</td>
</tr>
<tr>
<td>MUHEC</td>
<td>Massey University Human Ethics Committee</td>
</tr>
<tr>
<td>ISAK</td>
<td>International Society for Advancement of Kinanthropometry</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical package for the social sciences</td>
</tr>
<tr>
<td>RDI</td>
<td>Recommended daily intake</td>
</tr>
<tr>
<td>LOA</td>
<td>limits of agreement</td>
</tr>
<tr>
<td>SD</td>
<td>standard deviation</td>
</tr>
<tr>
<td>CI</td>
<td>confidence interval</td>
</tr>
<tr>
<td>r</td>
<td>correlation coefficient</td>
</tr>
<tr>
<td>df</td>
<td>degrees of freedom</td>
</tr>
<tr>
<td>t</td>
<td>test statistic</td>
</tr>
<tr>
<td>i.e.</td>
<td>in other words</td>
</tr>
<tr>
<td>k</td>
<td>weighted kappa statistic</td>
</tr>
<tr>
<td>p</td>
<td>p-value</td>
</tr>
<tr>
<td>n</td>
<td>number</td>
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