View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Massey Research Online

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

Bone mineral density and body composition in high-performing cricket players; an exploratory study

A thesis presented in partial fulfilment of the requirements for the degree of

Master of Science

In

Nutrition and Dietetics

at Massey University, Albany

New Zealand

Corey Payne

2017

Abstract

Background/Aim: Cricket is a popular sport both in New Zealand, and internationally. Cricketers have a high prevalence of stress fractures, which may in part be linked to bone mineral density. However, little research exists investigating bone health in this group. The primary aim of this study was to investigate determinants of bone mineral density (BMD) in a group of high-performing cricketers. Secondary aims included measuring musculoskeletal differences in the dominant versus non-dominant arm, and monitoring pre and postseason body composition.

Methods: Healthy male (n=27) and female (n=11) cricketers aged 16-33y were recruited. BMD was measured using DXA, and body composition was measured pre and post-season using bioelectrical impedance analysis (BIA). Food frequency questionnaires (FFQ's) and a lifestyle & health questionnaire were completed. Determinants of BMD were tested using hierarchical multiple regression analysis. A dependent samples t-test was used to determine differences between dominant and non-dominant arms and changes in body composition over the season.

Results: Skeletal muscle mass was a significant predictor of BMD and accounted for 31, 18, and 38 percent of BMD variation at the hip, spine, and total body, respectively. Age and calcium intake did not predict BMD at any site. BMD and lean mass were significantly greater ($p<0.05$) in the dominant arms of both males (+0.056g/cm^2 and +308.4g) and females (+0.078g/cm^2 and +254.2g). A 0.8kg reduction in post-season skeletal muscle mass was found in females ($p<0.05$), with no differences found in males.

Conclusions: Skeletal muscle was the strongest predictor of BMD in this group, while age and calcium intake showed no effect. Significant differences in BMD and lean mass were observed between dominant and non-dominant arms. Skeletal muscle in males remained unchanged from beginning to end of season, and was reduced in females. Training methods in this group should target development and maintenance of muscle mass in order to optimise BMD.

Acknowledgements

I would like to express my gratitude to a number of people who made this project possible.

Firstly, a big thank you to every participant who gave up their time to take part in this study – without your contributions none of this could have taken place. Also to the coaching staff at Auckland cricket; Nick White, Andre Adams, and Elfriede Chooi, who helped facilitate initial data collection and follow-up sessions – your assistance is greatly appreciated.

To my supervisors, Dr Kathryn Beck and Dr Pamela von Hurst, I am extremely grateful for your support, encouragement, valuable feedback, and your honesty – not to mention the amount of time you both spent assisting in data collection and working behind the scenes.

To my fellow researcher Shelley McDonald, thank you for all of your hard work during the recruiting and data collection process, and assistance throughout the entire journey.

Thank you to Owen Mugridge and P.C Tong for your assistance with data entry and analysis.

Lastly, thank you to my family and friends for your continued support and encouragement throughout this experience.

Table of contents

Abstract.....I

Acknowledgements.....II

List of tables.....VI

List of appendices.....VII

List of abbreviations.....VIII

Contributions to research.....IX

Chapter 1: Introduction.....1

1.1 Background.....1

1.2 Purpose of this study.....3

1.3 Aim.....3

1.4 Objectives.....3

1.5 Thesis structure.....4

Chapter 2: Literature review.....5

2.1 Determinants of bone mineral density.....5

2.1.1 Background.....5

2.1.2 Calcium.....6

2.1.3 Vitamin D.....8

2.1.4 Protein.....10

2.1.5 Fruit and vegetables.....12

2.1.6 Potassium.....13

2.1.7 Vitamin K.....14

2.1.8 Other micronutrients.....16

2.1.9 Calorie restriction and disordered eating.....16

2.1.10 Physical activity.....17

2.1.11 Smoking/tobacco use.....19

2.1.12 Alcohol.....20

2.1.13 Ethnicity.....21

2.1.14 Body composition……22
2.2 Differences in composition between dominant and non-dominant arms in athletes……23
2.3 Body composition and BMD in cricketers……24
2.4 Summary……26

Chapter 3: Methods……27
3.1 Participants and recruitment……27
3.2 Ethical approval……27
3.3 Research design and phases of data collection……28
3.3.1 Initial phase……28
3.3.2 Follow-up phase……30
3.3.3 Injury questionnaire……31
3.4 Dietary analysis……31
3.5 Statistical analyses……31

Chapter 4: Results……33
4.1 Participant characteristics……33
4.2 Body composition and bone mineral density……34
4.3 Lifestyle factors……35
4.4 Dietary intake……36
4.5 Determinants of bone mineral density (BMD)……38
4.6 Composition of dominant versus non-dominant arms……40
4.7 Changes in body composition over the season……41

Chapter 5: Discussion……43
5.1 Summary of key findings……43
5.2 Determinants of bone mineral density - Skeletal muscle mass……43
5.3 Nutritional considerations - calcium……45
5.4 Age as a predictor of bone mineral density……47
5.5 Other considerations when assessing stress fracture risk……47

5.6 Composition of dominant versus non-dominant arms……..48
5.7 Changes in body composition throughout the season……..50
5.8 Gender differences in BMD between males and females……..52

Chapter 6: Conclusion……53
6.1 Strengths and limitations of this study……..53
6.2 Recommendations for future research……..55
6.3 Concluding summary……..55

References……..57
Appendices……..76

List of tables

Table 1.1: *Contributions to this study*.....IX

Table 4.1: *Participant characteristics*.....33

Table 4.2: *Bone mineral density and body composition*.....34

Table 4.3: *Lifestyle and health factors including injury*.....36

Table 4.4: *Daily consumption of food groups compared to guidelines*.....37

Table 4.5: *Multiple regression analysis to determine factors associated with total BMD in male cricketers*.....38

Table 4.6: *Multiple regression analysis to determine factors associated with BMD at the spine in male cricketers*.....39

Table 4.7: *Multiple regression analysis to determine factors associated with BMD at the hip in male cricketers*.....39

Table 4.8: *Composition of dominant versus non-dominant arms*.....40

Table 4.9: *Female changes in body composition*.....41

Table 4.10: *Male changes in body composition*.....42

List of appendices

Appendix A: *Athlete diet index*.....76

Appendix B: *Questions from Food frequency questionnaire (FFQ)*.....89

Appendix C: *Calcium content of foods using foodworks 8*.....91

Appendix D: *Lifestyle and health questionnaire*.....92

Appendix E: *Injury questionnaire*.....101

Appendix F: *Standard operating procedure for BIA*.....104

Appendix G: *Standard operating procedure for DXA*.....106

List of abbreviations

BIA: Bioelectrical Impedance Analysis

BMC: Bone Mineral Content

BMD: Bone Mineral Density

BMI: Body Mass Index

Cm: Centimetre

CSA: Cross-sectional area

DXA: Dual X-ray Absorptiometry

FFM: Fat Free Mass

FFQ: Food Frequency Questionnaire

GFR: Glomerular filtration rate

IGF-I: Insulin-Like Growth Factor-I

IU: International units

Kg: Kilogram

Mcg: Micrograms

Mg/dL: milligrams per decilitre

Nmol/L: Nanomol per litre

UcOC: Under-Carboxylated Osteocalcin

UVB: Ultraviolet B

NASA: National Aeronautics and Space Administration

RDI: Recommended Dietary Intake

SD: Standard Deviation

SMM: Skeletal muscle mass

P: p-value (statistical analysis)

PTH: Parathyroid hormone

UL: Tolerable Upper Intake level

µg: Microgram

Contributions to research

Researchers	Contributions to the thesis
Corey Payne	Main researcher, data collection, data entry, statistical analysis, interpretation and discussion of results
Shelley McDonald	Co-ordination of participant recruitment, DXA testing, data collection, participant liaison
Dr Kathryn Beck	Main academic supervisor, data collection, guidance with structure, content, and statistical analysis, questionnaire design, interpretation of results, editing and formatting
Dr Pamela von Hurst	Academic supervisor and assistance with statistical procedures and analysis, DXA testing, BMD expertise, interpretation of results, editing and formatting
Owen Mugridge	DXA testing, equipment calibration, data analysis
P.C Tong	DXA testing and analysis, equipment calibration, assistance with online questionnaires, data storage
Julie Knight	DXA testing