

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.

**A comparison between a traditionally periodised programme and
a load autoregulated periodised programme for maximal
strength gain in the squat, bench press, and deadlift in weight-
trained males**

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

Master of Science

In

Exercise and Sport Science

at Massey University, Manawatū, New Zealand.

Jeremy Fraser

2016

Abstract

Background: Training towards the goal of improving maximal strength is commonly undertaken; particularly by athletes involved in contact sports, powerlifters, and recreational body builders. Multiple methods of programming exist, with autoregulated (AR) training being a popular topic within the training community. AR training involves day to day fluctuations in volume and/or intensity in order to accommodate the athlete's performance on a given day. This could potentially allow for greater gains in strength due to fine tuning of the fatigue-fitness interaction. However, scant research exists on AR training, with the vast majority being carried out on individuals during rehabilitation therapy.

Aim: To examine whether a load-autoregulated strength training programme is more effective in improving maximal strength in the squat, bench press, and dead lift than a traditionally periodised program, in experienced weight-trained individuals.

Methods: Eight healthy, recreationally trained males agreed to participate and completed this study. Each participant completed a traditionally (TD) programme and an AR programme in a randomised, cross-over design with a 2-week wash out period between. Each programme involved baseline one-repetition-maximum testing (1RM) in the barbell squat, bench press, and deadlift followed by eight weeks of training with subsequent 1RM testing. Following warm up, participants completed one set of as many repetitions as possible (AMRAP) at 85% of baseline 1RM, followed by subsequent working sets. 1RM Prediction equations were utilised in the AR training group to dictate load used in the working sets; whereas the TD groups subsequent sets were based on baseline 1RM.

Results: The squat, deadlift, and total improved significantly within each programme (all $p < 0.05$), however no differences between programmes were present (all $p > 0.05$). Bench press strength improvement was significantly greater in the TD programme (time x programme interaction $p < 0.05$).

Conclusions: The present study found no differences in effectiveness of programmes at producing strength gain in the squat, deadlift, or total weight lifted. However the TD programme resulted in a greater improvement in bench press strength compared to AR. Future research would also involve auto-regulated volume, as well as ensuring matched cross over design, and ideally a use of more trained participants.

Acknowledgements

I would firstly like to give thanks to Dr Matthew Barnes and Dr Darryl Cochrane. Matt was my supervisor for the past two years of postgraduate study. Through his help I was able to conduct research within the area of exercise science that I found the most interesting. He was always extremely efficient and helpful whenever I needed assistance on any topic related to my studies. Thanks to Darryl for assistance with the thesis, for the help with the formatting and the content within. Both of your down-to-earth, cheerful attitudes helped me to get through my studies (relatively) stress free!

To my participants; I cannot say thank you enough for the amount of time and effort you put in to enable me to conduct research. It was a big commitment for each of you to participate in a five month long training study, and for that I am grateful.

Thank you to my family. You have given me the opportunity to dedicate so much of my time to studying a topic that I am so passionate about.

Finally, thank you to my girlfriend Jasmine. Throughout my entire university life you have been a great source of motivation for me to complete all of my study to a high standard.

Table of Contents

Abstract	ii
Acknowledgements	iv
Table of Contents	v
Abbreviations	viii
List of Tables	x
List of Figures	xi
Chapter 1 – Introduction	12
Chapter 2 – Literature Review	15
2.1 Response to Resistance Exercise.....	15
2.1.1 Metabolic Fatigue.....	15
2.1.2 Mechanical Tension	16
2.1.3 Exercise Induced Muscle Damage	17
2.1.4 Neural Responses.....	18
2.1.5 Adaptation	19
2.2 Training Programmes	21
2.2.1 Non-periodised Programmes	22
2.2.2 Linear Periodisation versus Non-periodised Programmes.....	23
2.2.3 Reverse Linear Periodisation.....	24
2.2.4 Undulating Periodisation.....	25
2.2.4.1 Daily and Weekly Undulating Periodisation.....	27
2.2.5 Block Periodisation.....	30
2.2.6 Autoregulated Periodisation	31
2.2.7 Limitations of Previous Research.....	35
2.2.8 Summary	36
2.3 Maximal Strength Testing	44
2.4 Training for Maximal Strength Gain	45
Chapter 3 – Research Aim and Hypotheses	49
Chapter 4 – Methods	50
4.1 Overview.....	50
4.2 Participants	51
4.3 Experimental Protocol	51
4.3.1 Familiarisation Session	51
4.3.2 Wash-Out Period	52
4.3.3 Baseline Measures.....	52
4.3.4 Criteria for a Successful Lift.....	53

4.3.5 Programme Outline.....	53
4.3.6 Assistance Exercises.....	55
4.3.7 Training Diary & Participant Monitoring.....	56
4.3.8 Diet Control.....	56
4.3.9 Participation Compensation.....	57
4.4 Statistical Analysis.....	57
4.4.1 Formula validation.....	57
4.4.2 Training Volume.....	58
4.4.3 Training Intensity.....	58
4.4.4 Maximal Strength Performance.....	58
4.4.5 Submaximal Repetition Performance.....	59
Chapter 5 – Results	60
5.1 Bodyweight	60
5.2 Formula Validation	60
5.3 Training Volume.....	61
5.4 Training Intensity.....	61
5.5 Maximal Strength Performance	63
5.6 Submaximal Repetition Performance:.....	64
5.7 Order Effect of Training.....	66
Chapter 6 – Discussion	67
6.1 Primary Performance Measure: Maximal Strength.....	67
6.1.1 Training Volume.....	69
6.1.2 Training Intensity and Formula Validation.....	69
6.1.3 Order Effect of Training.....	70
6.2 Long Term Progress	70
6.3 Limitations.....	71
6.4 Future Research	72
Chapter 7 – Conclusion	73
References.....	74
List of Appendices.....	87
Appendix A.....	87
Appendix B.....	87
Appendix C.....	87
Appendix D.....	87
Appendix E.....	87
Appendix F.....	87
Appendix A.....	88

Participant Information Sheet.....	88
Appendix B.....	97
Health Screening Questionnaire.....	97
Appendix C.....	100
Training History Questionnaire.....	100
Appendix D.....	103
Consent Form.....	103
Appendix E.....	105
Training Diary.....	105
Appendix F.....	106
1RM Table Example (for squats and deadlifts).....	106

Abbreviations

A

AR	Autoregulated
AKT	Protein kinase B
AMRAP	As many repetitions as possible

B

BP	Block periodisation
B1	Baseline testing one
B2	Baseline testing two

C

CNS	Central nervous system
CSA	Cross sectional area

D

DUP	Daily undulating periodisation
-----	--------------------------------

E

EIMD	Exercise-induced muscle damage
EMG	Electromyography
ES	Effect size

F

FP	Foot position
F1	Final testing one
F2	Final testing two

G

g	Gravitational acceleration
---	----------------------------

H

HR	Heart rate
----	------------

K

kg	Kilograms
----	-----------

L

LP	Linear periodisation
M	
mTOR	Mammalian target of rapamycin
N	
NP	Non-periodised
R	
RIR	Repetitions in reserve
RLP	Reverse linear periodisation
RPE	Rating of perceived exertion
T	
TD	Traditionally periodised programme
U	
UP	Undulating periodisation
W	
WUP	Weekly undulating periodisation
W1T1	Week one trial one
W8T1	Week eight trial one
#	
1RM	One repetition maximum
3x10	3 sets of 10 repetitions per set

List of Tables

Table 2.1. Determining the magnitude of effect size in strength training research.....	20
Table 2.2. Summary of the methodology and performance changes of the various periodisation models.....	36
Table 2.3. Prilepin's table	44
Table 4.1. Assistance exercises prescribed following main exercise.....	53
Table 5.1. Formula validation 1.....	58
Table 5.2. Formula validation 2.....	59
Table 5.3. Volume performed in the squat, bench press, and deadlift, for each programme	59
Table 5.4. 1RM for each powerlift at baseline and following each programme.....	61
Table 5.5. Effect size for each exercise and total for each programme and their magnitude	62

List of Figures

Figure 2.1. Intensity and volume versus time for a NP programme.. Error! Bookmark not defined.	
Figure 2.2. Intensity and volume versus time for a LP programme 23Error! Bookmark not defined.	
Figure 2.3. Intensity and volume versus time for a RLP programme	24
Figure 2.4. Intensity and volume versus time for a WUP programme	25
Figure 2.5. Intensity and volume versus time for a BP programme representing blocks of muscular hypertrophy, maximal strength, and power	30
Figure 4.1. Timeline for experimental protocol	48
Figure 5.1. 1RM used to prescribe training load in the squat.....	60
Figure 5.2. 1RM used to prescribe training load in the bench press.....	60
Figure 5.3. 1RM used to prescribe training load in the deadlift	61
Figure 5.4. AMRAP performance in the squat	62
Figure 5.5. AMRAP performance in the bench press.....	63
Figure 5.6. AMRAP performance in the deadlift.....	63