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The impact of test loads on the accuracy of 1RM prediction using the load-velocity relationship



Mark G. L. Sayers^{1*}, Michel Schläeppli², Marina Hitz² and Silvio Lorenzetti^{2,3}

Abstract

Background: Numerous methods have been proposed that use submaximal loads to predict one repetition maximum (1RM). One common method applies standard linear regression equations to load and average vertical lifting velocity (V_{vertical}) data developed during squat jumps or three bench press throws (BP-T). The main aim of this project was to determine which combination of three submaximal loads during BP-T result in the most accurate prediction of 1RM Smith Machine bench press strength in healthy individuals.

Methods: In this study combinations of three BP-T loads were used to predict 1RM Smith Machine bench press strength. Additionally, we examined whether regression models developed using peak vertical bar velocity (V_{peak}), rather than V_{vertical} , provide the most accurate prediction of Smith Machine bench press 1RM. 1RM Smith Machine bench press strength was measured directly in 12 healthy regular weight trainers (body mass = 80.8 ± 5.7 kg). Two to three days later a linear position transducer attached to the collars on a Smith Machine was used to record V_{vertical} and V_{peak} during BP-T between 30 and 70% of 1RM (10% increments).

Results: Repeated measures analysis of variance testing showed that the mean values for slope and ordinate intercept for the regression models at each of the load ranges differed significantly depending on whether V_{vertical} or V_{peak} were used in the prediction models ($P < 0.001$). Conversely, the abscissa intercept did not differ significantly between either measure of vertical bar velocity at each load range. The key finding in this study was that 1RM Smith Machine bench press strength can be determined with high relative accuracy by examining V_{vertical} and V_{peak} during BP-T over three loads, with the most precise models using V_{peak} during loads representing 30, 40 and 50% of 1RM ($R^2 = 0.96$, SSE = 4.2 kg).

Conclusions: These preliminary findings indicate that exercise programmers working with normal healthy populations can accurately predict Smith Machine 1RM bench press strength using relatively light load Smith Machine BP-T testing, avoiding the need to expose their clients to potentially injurious loads.

Keywords: Strength assessment, Dynamic strength, Predictive models, Bench press throws

Background

The quantification of the maximum load that can be lifted through a full range of motion, or one repetition maximum (1RM), is fundamental to the design of resistance training programs [1]. Typically, 1RM is either measured directly or calculated indirectly using predictive models. The direct determination of 1RM suffers from a number of pragmatic

issues as it is not only time consuming, but the outcome is effected by factors such as athlete experience, technique, fatigue and motivation [2]. Traditional 1RM testing is considered to be safe when it is conducted in appropriate settings under the supervision of qualified practitioners [3, 4]. Regardless, this 1RM exposes athletes to large musculoskeletal forces, and there is some evidence that 1RM testing can be potentially injurious [5, 6] and may also be impractical with novices and/or in clinical settings [7].

Indirect methods for 1RM quantification tend to follow two different protocols, both of which rely on the

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1rm Prediction And Load Velocity Relationship

Joacim Rocklöv



1rm Prediction And Load Velocity Relationship:

Testing and Evaluation of Strength and Power Mike McGuigan, 2019-12-09 Strength and power are recognised as key components of human health and performance. Therefore it is vital for exercise scientists and strength and conditioning practitioners to be able to assess these qualities effectively. Testing methods of these components are often presented as standalone chapters in textbooks which provides the reader with an overview of these aspects. *Testing and Evaluation of Strength and Power* provides a detailed explanation of testing and evaluation methods for strength and power. The book considers the relationship between the methods of assessment research on the various approaches to evaluation and how practitioners and researchers can use the information in applied settings. The book provides the reader with a comprehensive overview of methods of strength and power assessment protocols and how they can be used to inform programming. This integrated approach to assessment of strength and power is recommended reading for students on strength and conditioning course and of vital reading to those on specialised courses on strength and power as well as coaches in the fitness testing and strength and conditioning disciplines.

Resistance Training Methods Alejandro Muñoz-López, Redha Taiar, Borja Sañudo, 2021-10-18 This book reviews the main principles of resistance training from basics to modern insights. It includes practical ways to develop most of the strength training methods including monitoring and testing procedures. It merges practical tips with knowledge about the scientific background concerning program and periodization. It describes procedures for special populations such as elderly or women. Gathering contributions by authoritative researchers and professors in the fields of sport science and biomechanics, this book provides an integrated view of strength training programming and describes the most important biological factors associated with this type of training. The evidence based and detailed description of each single mechanism to be trained to enhance performance is covered in depth. Thanks to its strong academic background and being self contained, this book offers a valuable reference guide for advanced undergraduate and graduate students in sports science as well as an inspiring guide for sport and health researchers and professional trainers alike.

Essentials of Strength Training and Conditioning G. Gregory Haff, NSCA -National Strength & Conditioning Association, N. Travis Triplett, 2026-03-02 Developed by the NSCA, *Essentials of Strength Training and Conditioning* explains key theories, concepts and scientific principles of strength training and conditioning as well as their direct application to athletic competition and performance. It is a key preparation resource for the CSCS exam.

Strength and Conditioning for Sports Performance Ian Jeffreys, Jeremy Moody, 2021-03-29 An effective strength and conditioning program is an essential component of the preparation of any athlete or sportsperson. *Strength and Conditioning for Sports Performance* is a comprehensive and authoritative introduction to the theory and practice of strength and conditioning, providing students, coaches and athletes with everything they need to design and implement effective training programs. Revised and updated for a second edition, the book continues to include clear and rigorous explanations of the core science underpinning strength and

conditioning techniques and give detailed step by step guides to all key training methodologies including training for strength speed endurance flexibility and plyometrics The second edition expands on the opening coaching section as well as introducing an entirely new section on current training methods which includes examining skill acquisition and motor learning Throughout the book the focus is on the coaching process with every chapter highlighting the application of strength and conditioning techniques in everyday coaching situations Strength and Conditioning for Sports Performance includes a unique and extensive section of sport specific chapters each of which examines in detail the application of strength and conditioning to a particular sport from soccer and basketball to golf and track and field athletics The second edition sees this section expanded to include other sports such as rugby union rugby league and American football The book includes contributions from world leading strength and conditioning specialists including coaches who have worked with Olympic gold medallists and international sports teams at the highest level Strength and Conditioning for Sports Performance is an essential course text for any degree level student with an interest in strength and conditioning for all students looking to achieve professional accreditation and an invaluable reference for all practising strength and conditioning coaches *The Journal of Applied Sport Science Research* ,1987 **Dissertation Abstracts International** ,2006 Monitoring Changes in Resistance Training Performance Following Overload and Taper Microcycles Tyler Dale Williams,2017 During competition preparation a common practice of strength athletes is to utilize a short term overload period followed by a taper to enhance strength performance Three studies were conducted to evaluate changes in repetition velocity estimated repetitions to failure ERTF and smartphone derived heart rate variability HRV across overload and taper microcycles The first study examined changes in bench press average concentric velocity ACV recorded during a load velocity profile assessment consisting of loads ranging from 40 85% of one repetition maximum 1RM Additionally this study investigated whether the load velocity relationship could accurately predict bench press 1RM Following an overload microcycle PostOL ACV of the load velocity profile was significantly reduced compared to baseline BL however 1RM was unchanged Following the taper PostTP ACV had returned to BL while 1RM was significantly higher than PostOL and BL The load velocity profile was unable to accurately predict 1RM however the near perfect correlations suggest that it may be used to assess recovery and adaptation to resistance training The second study evaluated the accuracy of ERTF during a bench press repetitions to failure assessment with 70% 1RM There was no difference between ERTF and actual repetitions to failure ARTF during BL and PostOL however ARTF were significantly higher than ERTF at PostTP Further PostTP ARTF and ERTF were both significantly higher than PostOL while ARTF were also higher than BL Thus the accuracy of ERTF is dependent on the proximity to muscular failure The third study evaluated changes in HRV across overload and taper microcycles Additionally this study investigated the intra day reliability of HRV measured upon waking HRVM and upon arriving to the training facility HRVT HRVM decreased significantly at PostOL and returned back to baseline at PostTP While HRVT followed a similar trend

there were no statistical difference across BL PostOL and PostTP There were large to very large correlations between HRVM and HRVT during BL and PostOL while the relationship at PostTP was not significant Smartphone derived HRV recorded upon waking was sensitive to resistance training loads across an overload and taper microcycle in competitive strength athletes whereas HRV taken just before the training session was not

Predictive Validity of the Snatch Pull Force-velocity Profile to Determine the Snatch One Repetition-maximum in Male and Female Elite Weightlifters Ingo Sandau,Helmi Chaabene,Urs Granacher,2021 Abstract Background The prediction of one repetition maximum 1RM performance from specific tests is highly relevant for the monitoring of training in weightlifting Therefore this study aimed at examining the predictive validity of the theoretical 1RM snatch snatchth computed from the two point snatch pull force velocity relationship FvR2 to determine actual snatch 1RM performance in elite weightlifters Methods Eight three female five male elite weightlifters carried out a 1RM snatch test followed by a snatch pull test with loads of 80% and 110% of the previously determined 1RM snatch Barbell kinematics were determined for all lifts using video tracking From the snatch pull barbell kinematics the snatch pull FvR2 was modeled and the snatchth was calculated Results The main findings indicated a non significant p 0 706 and trivial d 0 01 mean difference between the actual 1RM snatch performance and the snatchth Both measures showed an extremely large correlation r 0 99 The prediction accuracy of the actual 1RM snatch from snatchth was 0 2 1 5 kg systematic bias standard deviation of differences Conclusions This study provides a new approach to estimate 1RM snatch performance in elite weightlifters using the snatch pull FvR2 The results demonstrate that the snatchth model accurately predicts 1RM snatch performance

The Efficacy of the Load-velocity Profile to Predict One Repetition Maximum Stephen William Thompson,2022

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