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Predicting Load Carriage Performance: A Critical Review

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Introduction

• In recreational and occupational pursuits, as well as completing daily tasks, humans may be required to carry external loads on their bodies.
• The diversity and complexity of human load carriage differs significantly between populations, age groups and occupations.
• Load carriage can be comprised of carrying tools, water, food, equipment, backpacks or personal items across varying and changing terrains and at differing speeds.
• Recreational male and female hikers self-reported backpack loads of up to 29% of their body weight while hiking for a daily task, humans may be required to carry external loads on the musculoskeletal system, resulting in back, ankle, knee, neck and shoulder injuries [2].
• Give the potential for injuries and negative impacts on recreational activities, occupational demands and daily life requirements, a means of accurately predicting the costs of load carriage tasks on the human system may be of great benefit.
• The purpose of this critical review was to identify all relevant studies to load carriage and predictive formulas and performance, to critically appraise these studies, and to synthesize their findings.

Methods

• An extensive search of key databases was conducted to identify studies to inform this review. These databases were used for their applicable context and broad range of scholarly, peer reviewed sources (Figure 1).
• Key search terms were determined by completing a rapid literature review and noting relevant themes appropriate for this literature review and the ability of terms to identify previously known literature in this field.
• Articles were critically appraised to determine the methodological quality by two authors (B.D.& M.M.) using a modified Downs and Black Checklist [3].
• The level of agreement was measured through Cohen’s kappa (k = 0.72).
• Sex of participants: Male only participants (n=6); Even split between male and female participants (n=2)
• Population of studies: Military populations (n=4), University participants (n=1), General public or the population was not reported (n=5).
• Countries of origin: USA (n=8), Israel (n=1) and Belgium (n=1).
• Loading conditions varied between the 10 studies appraised with the minimum load used being no load and maximum load carried reported as 70 kg.
• Oxygen consumption was utilized to measure energy expenditure across all 10 studies. Vo2 max was reported in 4 studies ranging from 45.1±1.5 ml/(kg.min) to 58.5±1.5 ml/(kg.min), reported standing metabolic rate, 2.37 (2.12-4.18) mlO2/s for female participants and 4.73 (2.91-6.18) mlO2/s for male participants.. The remaining 4 studies did not report on Vo2 max or standing metabolic rates of their participants.
• This research found a variety of predictive equations being used to access load carriage energy cost requirements: Pandolf equation (1977) [5]
  M = 1.5w + 2.0(W + L) / (W + L) [1.5w + 2.0(W + L)]
  Soule equation (1972) [6]
  M = r(W/L) (2.7 + 3.2L-0.71L)1.65
  Pimental and Pandolf (1979) [7]
  4.5 M + 6 (M + B/(8M)+2+(M+B)) 4.5 M + 6.1 V G

Results

• Of the studies 10 included, the mean CAS was 56% with scores ranging between 38% and 76% (Figure 2).
• The level of agreement between rater was considered as substantial agreement (k = 0.72).
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Conclusions

• Of the 10 critically appraised articles in this review, it is evident that a clear and concise equation that can be used as a predictive measure to accurately predict load carriage performance across varying conditions is lacking.
• Considering the wide-ranging requirements and contexts in which loads are carried, the potential for injuries and the potential negative impacts on recreational activities, occupational demands and daily life requirements, further research into a means of accurately predicting the costs of load carriage tasks on the human system may be of great benefit.

Key References