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Establishing a bona fide physical assessment and performance standard for mines rescue personnel in New South Wales

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RESEARCH QUESTION AND OVERVIEW OF METHODOLOGY:

This investigation is seeking to determine if bona fide physical assessments can be developed to confirm the critical physical requirements to conduct mines rescue activities in New South Wales.

On the basis of a consensus within the scientific literature on the methodological approach required for the development of physical standards for employment five steps are proposed:

Step 1: Formation of a project management group.
Step 2: Determine the physical demands and minimum acceptable standards of performance.
Step 3: Measure the physical demands of critical mines rescue activities.
Step 4: Develop the assessment protocol based upon the critical physical demands.
Step 5: Finalisation of the assessment and minimum standard of occupational fitness**.**

Researchers have now completed all stages required for the establishment of *bona-fide* physical employment standards for miners.

OUTCOMES

- October 2017
    - Completion of an investigation to determine the effect of familiarisation on performance of the physical employment standard assessment for Brigadesmen.
    - 16 unskilled participants were assessed at the University of Wollongong to determine the magnitude of improvement in physical performance due to practice and familiarisation.
    - Preparation of the final draft report.
- November 2017
    - Presentation of the final draft report to the project management group.
    - Delivery of a University of Wollongong's resistance device used for the hose drag component of the assessment.
- December 2017
    - Finalisation of reporting.

RELIABILITY OF THE PROPOSED PHYSICAL EMPLOYMENT STANDARD ASSESSMENT:

When setting minimum acceptable standards for physical assessments, it is important to formally consider improvements in performance that may occur from increased familiarisation or efficiency in the performance the assessment circuit. Thus, improvements in performance unrelated to the physical fitness of the participant need to be formally considered and quantified. Therefore sixteen (16) unskilled participants (Table 1) were recruited and asked to perform the assessment as quickly as possible on three separate occasions. Using this methodology we can determine the maximum improvement most likely to occur with familiarisation. The data below shows that a 65 s

improvement in performance of the circuit had occurred. Thus, it was recommended a brigadesmen who achieves a completion time within 65 s of the minimum acceptable performance standard, should be given another opportunity to complete the assessment. By adopting this approach Coal Service Health can formally account for improvements in completion time that may have occurred due to practice and improved familiarisation with the proposed test circuit.

Table 1: Descriptive statistics for the unskilled participants used in this phase, the Brigadesmen who participated in this project, and data provided by Coal Services on coal miners.

	Unskilled		**Brigadesmen**		**Coal miners**	
	Mean	Range	Mean	Range	Median	25th, 75th
Age (y)	29.6 (11.4)	20-64	40.4 (8.9)	27-60	42.7	32.7, 52.7
Height (m)	1.78 (0.1)	1.62-1.86	1.79 (7.3)	1.62-1.96	1.77	1.73, 1.82
Body mass (kg)	79.3 (8.5)	65.9-94.8	91.8 (12.5)	65.1-125.6	88	79, 98
Body mass + load (kg)	101.4 (8.3)	87.9-117.2	113.0 (12.6)	86.7-147.8	N/A	
Carried load (kg)	22.1 (0.7)	20.5-22.8	21.1 (1.7)	17.2-23.8	N/A	

Data reported as mean, standard deviations in parentheses and ranges. Unskilled volunteers (n=16), Brigadesmen (n=83), and coal miners (n=9790). Coal miner data reported as median and 25th and 75th percentiles. The carried loads included all personal protective equipment (breathing apparatus, mining belt, self-rescuer and boots).

On their first attempt (Table 2), participants completed the test circuit in 29 min 10 s (SD 35 s). The total rest and recovery time, between the treadmill walk and part one and between part one and the shelf-stacking test, was 7 min 6 s (SD 27 s), therefore the actual work time was 22 min 3 s (SD 54 s). On average, participants improved their performance (Table 12) on the second trial for both parts one (25 s faster [SD 14]) and two (39 s [SD 25]), providing a significant overall improvement of 64 s (SD 31; $P<0.05$). On the third attempt, a significant change was not realised for part one ($P>0.05$), but for part two, further improvements were realised (17 s [SD 13]; $P<0.05$). This contributed to an overall significant average improvement of 26 s (SD 26).

Despite participants completing the assessment in a faster time on each successive attempt, the average oxygen consumption remained similar across the three trials, when averaged across the entire duration of the test circuit. However, the average oxygen consumption for parts one and two, when analysed in isolation, showed a significantly greater oxygen consumption in the second trial relative to the first trial (P<0.05). No differences were evident between trials two and three (P>0.05). Representative data are provided for the three trials on one individual (Figure 1).

Table 2: Performance times and physiological strain during the physiological aptitude test circuit.

	Trial			Attempt change (%)	
Test component	**1**	**2**	**3**	**1 versus 2**	**2 versus 3**
Part one (s)	174 (27)	148 (27)*	139 (28)	14.5 (7.5)	6.2 (12)
Part two (s)	250 (35)	211 (30)*	194 (29)*	15.1 (8.4)	7.7 (5.7)
Total rest (s)	546 (27)	572 (27)*	581 (28)	4.7 (2.7)	1.7 (3.4)
Total test time (s)	1750 (35)	1714 (29)	1697 (27)	2.2 (1.4)	1.0 (0.7)
Total work time (s)	1323 (54)	1259 (54)*	1233 (55)*	4.8 (2.2)	2.1 (2.0)
Mean oxygen consumption ($L.min^{-1}$)	2.0 (0.1)	2.0 (0.1)	2.0 (0.1)	N/A	N/A
Peak oxygen consumption ($L.min^{-1}$)	3.5 (0.4)	3.7 (0.5)	3.9 (0.6)*	N/A	N/A
Mean heart rate ($beats.min^{-1}$)	137 (18)	140 (18)	138 (17)	N/A	N/A
Peak heart rate ($beats.min^{-1}$)	178 (16)	185 (13)	181 (19)	N/A	N/A
Part one: Mean oxygen consumption ($L.min^{-1}$)	2.9 (0.4)	3.3 (0.4)*	3.4 (0.5)	N/A	N/A
Part one: Mean heart rate ($beats.min^{-1}$)	160 (16)	164 (12)	163 (17)	N/A	N/A
Part two: Mean oxygen consumption ($L.min^{-1}$)	2.4 (0.2)	2.6 (0.3)*	2.7 (0.3)	N/A	N/A
Part two: Mean heart rate ($beats.min^{-1}$)	165 (17)	170 (11)	170 (18)	N/A	N/A

Data reported as mean with standard deviations in parentheses. Total work time is calculated as total test time less the rest time. * denotes significant difference (P<0.05) when compared to the previous attempt.

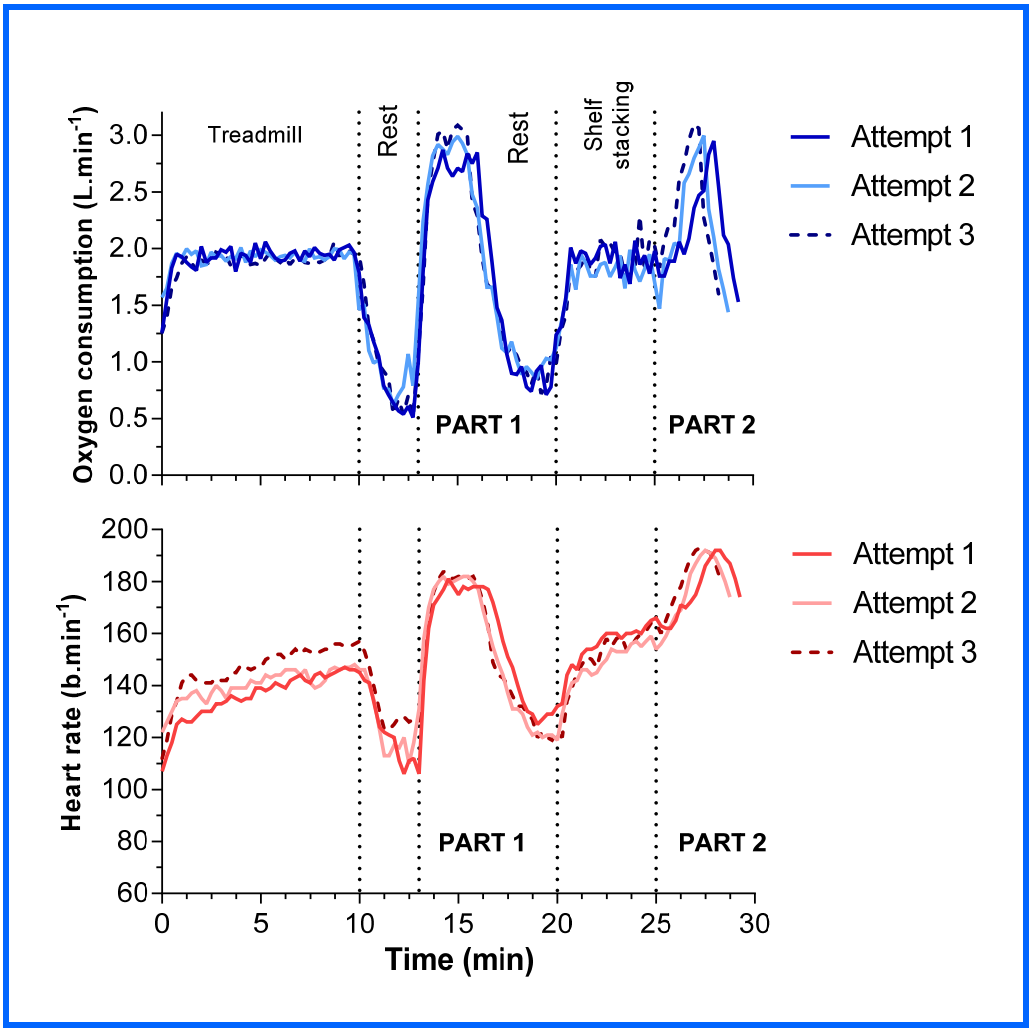

Figure 1: The oxygen consumption and heart rate responses of one participant during three successive trials of the physiological aptitude test circuit. From 0-10 min the participant performed the treadmill walk, rested for 3 min prior to performing part one (dummy drag, unilateral and bilateral carries and hose-drag tests). The second rest period varied in time due to the self-selected pace of the participant in Part one of the circuit and the fixed start-time for the shelf stacking test (20 min). Part two of the physiological aptitude test circuit comprised of the digging, the second unilateral carry and the lift and hold tests.