POSTER P1

Manual Wheelchair Energy Efficiency Configurations for Elderly Carers

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Summary
Many elderly and frail carers find manual wheelchairs hard to push and due to the home environment, transport reasons or capabilities of the carer and client, add on power packs or electric wheelchairs are not suitable solutions.

Aims and Objectives
This research investigates the feasibility of determining a relationship between wheelchair configuration and energy expenditure for a carer pushing a wheelchair. Furthermore the relationship will be examined to identify if it can be utilized to develop a protocol for assessors configuring a wheelchair to take account of the needs of a main carer.

Background

Method:
As this was a feasibility study, ten volunteers within the Artificial Limb and Appliance Service (ALAS) were sourced. The weight, age, gender and height of each volunteer were recorded and each was connected to the vital signs monitor [1] to record individual SPO2, heart and respiration rates.

Seven Invacare Action 2 NG wheelchairs [2] were configured differently from the factory settings (handle height, castor diameter and back wheel tyre, diameter and position). An anthropometric dummy weighing 77kg was then placed in the wheelchair.

Each volunteer was asked to push a wheelchair configuration around a figure-of-eight course for 150m at his/her own pace. S/he was then given time to rest and repeated pushing the same configuration a further two times with rests in-between. This pattern was repeated for all seven wheelchairs so that each volunteer trial lasted approximately 3 hours and 45 minutes.

Results:
The data was examined with the statistical analysis package SPSS and was treated as an ANOVA with a repeated measures analysis.

Null Hypothesis H_O: There is no variation in one volunteer's normalised heart rate with different configurations of the wheelchair.

Alternative Hypothesis H_A: There is a variation in one volunteer's normalised heart rate with different configurations of the wheelchair.

These hypotheses were repeated a further two times for SPO2 saturation percentage and respiration rate. The analysis showed that there were no statistically significant differences between the results.

The data collected from the volunteers was ranked in order to obtain the most energy efficient configuration. The SPO2 values were omitted due to the lack of reliability of the gathered data.

It was found that wheelchair configuration 1, the traditionally assumed most efficient configuration (pneumatic self-propel wheel set forwards, large castors and the correct handle height) had the joint hardest effort along with wheelchair 2 (transit wheels). Wheelchair 7, the traditionally assumed least efficient configuration (solid transit rear-set wheels with a high handle and small front castors) had the joint least effort along with wheelchair 4 (solid wheels).

The tilt tests concluded that only one wheelchair would fail and tip at a slope angle of 12° (wheelchair 2 uphill), assuming the position of the Centre of Gravity (CoG) was maintained and no dynamic forces were applied.

The volunteers were classified into fitness groups depending on their answers to the International Physical Activity Questionnaire [3]. They were further divided according to their gender and age range. The data for a volunteer(s) fitting a particular subsection was plotted on a graph that can be used through reverse engineering by an assessor to obtain the order of the components to configure when adjusting a wheelchair for the main carer.

Discussion

Due to statistically insignificant results neither of the hypotheses can be assumed (as the number of volunteers was too small) and the counter-intuitive results from the data may be explained due to the wheelchairs not being identical (some castors were inline and some were offset). Other factors that need to be addressed with further investigation include the variation in wheelchair weights, rest periods, speeds of the volunteers and CoG changes.

References

[1] Philips Electronics (2012) IntelliVue MP2 patient monitor [online] available from <http://www.healthcare.philips.com/us_en/products/patient_monitoring/products/intellivue_mp2/>

[2] Invacare (2011) Product Catalog Action 2 NG [online] available from <http://doclibrary.invacare.fr/Office/Europe/Marketing/MktDocCor.nsf/MListeDocument?openform&bu=2000&subgroup=2300&family=2320&product=55_A2NG>

[3] International Physical Activity Questionnaire Group (2012) [online] available from <https://sites.google.com/site/theipaq/questionnaires>

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