**Age suit simulation replicates in healthy young adults the functional challenges to balance experienced by older adults: an observational study**

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**ABSTRACT**

**Background** Age simulation can have a positive effect on empathic understanding and perception of ageing. However, there is limited evidence for its ability to replicate objectively the physical and functional challenges of ageing.

**Objective** To observe whether age suit simulation can replicate in healthy young adults the physical and physiological balance disturbance and falls risk experienced by older adults.

**Methodology** Healthy young adults aged 20-40 years (16 male) were recruited to the study using convenience sampling from a student population. Participants performed three validated balance tests - Functional Reach Test (FRT), Timed Up and Go (TUG) and Berg Balance Scale (BBS) - first without the age suit and then with the age suit, using a standardised protocol, following the same sequence.

**Results** 30 participants completed all tests. Statistically significant differences between without-age-suit and with-age-suit performance were recorded for FRT distance (*p*<0.000005), time taken to complete the TUG (*p*<0.0005), and BBS score (*p*< 0.001). A comparison of participant scores with normative FRT and TUG scores identified that the suit had ‘aged’ the majority of participants to the normative values for older adults (60+), with some reaching the values for individuals aged 70-89. However, no scores achieved the values indicative of increased falls risk.

**Conclusions** The age suit is a valid educational tool that extends the value of age simulation beyond a more general empathising role, enabling those working with an older population to experience and understand the functional challenges to balance experienced by older adults as part of their training.

**What is already known on the subject**

* Evidence suggests that age simulation can have a positive impact on student understanding and perception of ageing
* Age suit simulation enables healthcare students to gain a greater understanding of the functional issues associated with ageing
* This greater understanding has been shown to increase empathy with older adults

**What this study adds**

* Age suit simulation aged healthy young adults into the normative values for older adults for the FRT and TUG
* BBS scores, although only slightly reduced with age suit simulation, were still indicative of an increased falls risk
* Age suit simulation is a valid educational tool for experiencing the functional challenges to balance experienced by older adults.

**INTRODUCTION**

Falls are the commonest mechanism of injury in older adults and the prevalence of falling increases with age,[1] with 30% of adults aged over sixty-five and 50% of those over eighty years falling at least once annually.[2] The physical and psychological trauma resulting from falling has a significant impact on health, quality of life, and healthcare costs.[2] NICE[2] advocate a multifactorial assessment and management approach involving a range of healthcare professionals (HCPs).

It is important that people working with older adults understand the physical and psychological challenges faced by this population; experiences of and education about older adults have been shown to directly influence perceptions about older people and can impact on the quality of care delivered to this population.[3] Simulation has been used in healthcare to facilitate this understanding in a range of healthcare professions and has been shown to increase empathy and facilitate more positive attitudes towards older adults.[4] Study methods have included strategies such as simulation stations,[5] working with simulated participants,[6] and high fidelity simulation.[7]

Age simulation suits are designed to simulate the human ageing process by replicating loss of joint range of movement, postural changes, muscle weakness, sensory and visual changes. Evidence suggests that wearing the age suit can increase the appreciation of the feelings experienced by older adults during everyday tasks, and facilitate a better understanding of the needs of this population.[8] which in turn can improve the care of older adults in our healthcare systems. However, the value of age suit simulation could be further enhanced if it could be shown to objectively recreate the specific challenges to movement and function experienced by older adults, reinforcing the value of this experiential learning in enabling those who work with this older population to more fully appreciate the challenges they experience. This is especially true of falls, where significant healthcare input is required to reduce falls risk. However, evidence is lacking on the ability of age suit simulation to replicate effectively and objectively the degree of balance disturbance and falls risk experienced by older adults.

The purpose of this study was to investigate whether age suit simulation can replicate in healthy young adults the physical and physiological balance disturbance and falls risk experienced by older adults.

**METHODS**

**Design**

A single group without- and with-suit design was undertaken, in which 30 healthy young adults performed three balance tests (Functional Reach Test (FRT), Timed Up and Go (TUG) and Berg Balance Scale (BBS)) first without the age suit and then with the age suit, using standardised protocols.

**Setting**

Participants were tested in a lab setting at Keele University on a pre-arranged and mutually agreed date, between September 2016 and November 2016. Data from each participant were all collected during one session on the same day.

**Ethics**

The study was approved by the School of Health and Rehabilitation Research Ethics Committee at Keele University. All data were anonymised and participant confidentiality was maintained throughout.

**Participants**

A convenience sample of 30 healthy young adults aged 20-40 years were recruited from the student population within the School of Health and Rehabilitation at Keele University. They were recruited by an e-mail sent by the lead author (CAW) to all undergraduate student cohorts in the school. Interested volunteers were screened for eligibility and excluded if they presented with any current physical or cognitive impairments that would affect results of balance tests and prevent understanding and following of instructions. Written consent was obtained prior to participation in the study. A sample size of 30 was considered to be sufficient to approximate a normal distribution.[9]

**Simulation intervention**

The Adam,Rouilly AK060 age suit[[1]](#endnote-1) uses a combination of joint restrictors, distal limb weights, a back brace and gloves, goggles and ear plugs to mimic the reduced range of movement, muscle weakness, flexed posture and sensory loss experienced by those older adults significantly affected by ageing. All the age suit components are fitted individually.

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**Outcomes**

The FRT, a valid and reliable tool for screening falls risk in older adults, provides ratio level data (distance) and has normative values based on age and gender[10] (Table 1).

**Table 1: Functional Reach Test mean and standard deviation reach distances for male and female adults according to age band[10]**

|  |  |  |
| --- | --- | --- |
| Age (years) | Mean (SD) reach distance (cm) | |
|  | Male | Female |
| 41-69 | 37.8 (5.6) | 35.1 (5.6) |
| 70-87 | 33.5 (4.1) | 26.7 (8.9) |

*SD = standard deviation*

*cm = centimetres*

The TUG is a measure of functional mobility involving timed sit-to-stand and initiation of walking, shown to have good reliability and validity,[11] providing ratio level data (time), and has age related normative values for older adults[12] (Table 2).

**Table 2: Timed-up-and-Go mean, standard deviation (SD) and 95% confidence intervals (CI) time for male and female adults according to age band[12]**

|  |  |  |  |
| --- | --- | --- | --- |
| Age (years) | Mean (SD) time (seconds) | | |
|  | Male | Female |
| 60-69 | 8 (2)  95% CI [7, 8] | 8 (2)  95% CI [7, 9] |
| 70-79 | 9 (3)  (95% CI [7, 11] | 9 (2)  (95% CI [8, 10] |
| 80-89 | 10 (1)  (95% CI [9, 11] | 11 (3)  (95% CI [9, 12] |

The BBS is a valid and reliable measure of functional balance,[13] scored by summing the score for each section (of which there are 14), providing ordinal level data; each point drop (from the maximum of 56) is associated with an increased risk of falling.[14] A drop in score between 56 and 54 points equates to a 3–4% increased falls risk and a drop to between 54-46 points equates to a 6–8% increased falls risk.[14]

**Procedure**

All participants performed the three tests in the same order, first without and then with the age suit. The order of testing was determined by the energy expenditure required for each test, with the FRT completed first, followed by the TUG and BBS. At each of the three test stations, one researcher carried out that test on all participants and followed a standardised procedure based upon the instructions described in the literature.[15] Each test was demonstrated to each participant prior to the without-suit testing to further standardise the testing procedure.

**Data analysis**

Without- and with-suit performance measurements were recorded for all three tests. Mean differences and 95% confidence intervals (95% CI) were calculated and analysed using related samples Wilcoxon Signed Rank Test for FRT and BBS (data not normally distributed), and *t* test for TUG (data normally distributed). IBM SPSS statistics software package, version 64, was used for data analysis. Significance was set at *p*<.05. Gender differences for without-suit and with-suit performance were also compared for the FRT.

**RESULTS**

From a student body of 270, a total of 30 young adults volunteered, screened and found to be eligible, and subsequently recruited. There were no withdrawals and no exclusions due to health issues. The male:female ratio was 16:14, and age range 20-40 years. The participants had no previous experience of the age suit within the academic setting

Table 3 shows the without-suit and with-suit scores, and the change scores, for all three measures (FRT, TUG, and BBS).

**Table 3: Without-suit and with-suit scores and change scores (difference) for FRT, TUG and BBS**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test** | **Without suit** | **With suit** | **Difference** |
| FRT distance (cm) | 36.90 (34.80, 40.90)  (range 30.10–56.90) | 31.25 (27.10, 34.20)  (range 18.50–45.00) | 5.8 (2.4, 10.1)# |
| TUG time (s) | 6.68 (0.63)  (range 5.55–7.88) | 8.41 (0.79)  (range 7.20–10.10) | 1.73 (0.74)$  95% CI [1.46, 2.01] |
| BBS | 56 (0, 0)  (range 55–56) | 55 (54, 56)  (range 50–56) | 0.5 (0, 2)\* |

*FRT and BBS scores are shown and median and interquartile ranges (IQR)*

*TUG scores are shown as mean and standard deviation (SD) and 95% confidence intervals (95% CI) for the change score (difference)*

*\*p*<.0005 *#p*<.000005 *$p*<.000001

**Functional Reach Test**

With-suit performance scores were lower than without-suit scores for all 30 participants, indicating a reduction in distance reached when wearing the age suit. With-without suit median difference in FRT performance was highly significant. Furthermore, median change scores were highly significant for both genders (male p<.0005, female p<.00005).

Figure 2 represents the distribution of without-suit and with-suit FRT scores. The number of students reaching normative values for 41-69 years was 6 (20%) and reaching normative values for 70-87 years was 21 (70%).

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The mean with-suit score for male participants (32.98 cm) reflected normative values for males aged 70-87 years whilst the mean with-suit scores for female participants (29.03 cm) mirrored normative values for females aged 70-87 years, based upon the published gender and age normative values.[10]

**Timed Up & Go**

With-suit TUG scores were greater than without-suit scores for all 30 participants, indicating an increase in time taken to ‘get up and go’ when wearing the age suit. Difference in performance between conditions was highly significant. Results were highly significant for both males and females (p<.000005). Figure 3 shows the distribution of without-suit and with suit scores.

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Using published TUG age related normative values,[12] 13 participants (eight female, five male) wearing the age suit demonstrated TUG scores indicative of normative values for age 60-69; five participants (one female, four male) demonstrated normative scores for age 70-79; one participant (female) achieved a score indicative of the normative values for age 80-89. The remaining 11 participants (four female, seven male) had a with-suit score <8 seconds, which was below the normative values for older adults.

**Berg Balance Scale**

With-suit BBS were lower than without-suit scores for 50% of participants. The maximum BBS score of 56 was attained by 97.7% (n=29) of without-suit participants. There was a statistically significant median (IQR) with-without difference, and results were significant for both males and females (p<.01).

Figure 4 shows the distribution of scores for without-suit and with-suit BBS scores. The number of students demonstrating a 3-4% increased risk of falls was 15 (50%) and with a 6-8% increased risk of falls was 1 (3%).

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In summary, whilst wearing the age suit, a large proportion of this sample of healthy young adults experienced a reduction in physical performance that reflected the age related normative values for the FRT (90%) and the TUG (63%), and 53% demonstrated an increased falls risk as indicated by their BBS scores.

**DISCUSSION**

The objective of this research project was to investigate whether age suit simulation could replicate in healthy young adults the functional challenges to balance experienced by older adults, using the FRT, TUG and BBS as outcome measures. The main findings of the study were that wearing the age suit did significantly affect performance on all three measures compared to performance when not wearing the age-suit. All the young participants were aged into the normative values for older adults (FRT & TUG), with 16 participants demonstrating a slight increase in falls risk (BBS); each one-point drop in BBS score was associated with a 3-4% increase in falls risk.[16] However, BBS scores did not achieve the values indicative of the increased falls risk demonstrated by balance-challenged older adults as identified in the literature.[10,11,12]

Older adults at risk of falling present with poor balance due to a combination of age-related physiological changes, co-morbidities and fear of falling.[16] The aim of the age suit is to attempt to replicate the physiological changes that occur with ageing, by altering both the sensory and motor processes that contribute to altered postural control. Gloves and goggles are worn to replicate the altered sensory component, and joint restrictors and weights are worn to mimic the reduced range of movement, and decreased muscle strength. These adjustments were sufficient to age the performance of our healthy young participants into the normative values for older adults.

However, it is important to note that higher level integrative processing, involving adaptive control from the cerebellum, basal ganglia and indirect pathways, contribute to postural control by modifying sensory and motor systems in response to changing task and environmental demands.[17] The changes to the higher integrated centres experienced with ageing[17] were not possible to simulate with the age suit, which may go some way towards explaining why no participants achieved the values for increased falls risk in the FRT and TUG or demonstrated more than a minimal drop in total score in the BBS. Additionally, it is unlikely that the psychological aspects such as fear of falling could be replicated in this population.

The FRT and TUG not only have normative values and a threshold score beyond which falls risk is increased, they also explore specific factors associated with poor balance, such as a limitation to forward excursion due to reduced anterior righting reactions (FRT) and slowed walk speed and sit to stand (TUG). In contrast, the BBS assesses functional tasks associated with a gradually increasing demand on posture and balance. Our participants took longer to complete the BBS tasks with the suit than without, suggesting that the suit did adversely affect performance, but the lack of aged-normative time scores or descriptors relating to the quality/effort of the movement meant that successful completion of the task occurred despite increased duration and effort. However, given that each point drop in BBS score is associated with an increase in falls risk,[14] age suit simulation was still able to effect a changed falls risk in 16 participants.

Within this study, some participants did not reach the normative values for older adults and other physical factors may have influenced our results. For example, despite there being an overall decline in performance on the TUG for all participants, seven of the eleven participants not reaching the TUG older adult normative values were male. Given that male skeletal muscles have a higher maximum power output,[18] the effect of the age suit weight (which could not be adjusted) may have been less successful in limiting performance and in mimicking the muscle weakness experienced by older adults in our male participants than in our female participants.

Previous studies[8,19] have explored the value of the age suit as a simulation learning tool, primarily focusing on enabling the wearer to experience the challenges faced by older adults during every day functional tasks. Post-simulation evaluations in these studies demonstrated that participants gained a greater understanding of the physical challenges that older adults face, increased empathy for the ageing population, a greater intention to provide better care for older people, and an overall enjoyment of the simulation experience. However, our study has now added new data to that body of evidence by showing that the age suit ages the performance of healthy young adults during functional tasks, thus extending the value of age simulation beyond a more general empathising role. People working with older populations can now, by wearing the age suit as part of their training, experience and gain insight into the specific functional challenges to balance experienced by older adults.

The population not only in the United Kingdom but across the world is ageing,[20] which in turn will result in an increasing older population at risk of falls.[21] As a result, people who work with older adults within health and social care settings will be increasingly required to successfully manage falls risk. Whilst empathy and understanding of the functional challenges faced by older adults are important requirements for practitioners and should never be undervalued, the ability to objectively recreate the specific challenges to balance and function experienced by older adults can only serve to reinforce this and also extend the value of age simulation as a valid experiential learning tool specific to falls assessment and management. A translation of this experiential learning into practice should in turn facilitate more effective management of balance challenged older adults based upon a fuller appreciation of the challenges they face. This in turn will hopefully translate into improved care of older adults within our healthcare systems.

**Limitations**

One limitation of the study was the element of fatigue that participants experienced; despite the three balance tests being performed in order of energy expenditure, participants were still reporting fatigue when performing the tests consecutively whilst wearing the age suit. Fatigue induced by moderate exercise has a negative impact on the control of balance.[22] However, the level of fatigue experienced by participants in this study was not quantified and, therefore, it is not known whether or to what extent fatigue had an impact on performance in the later tests. Yet, despite fatigue being a potential issue, it may have actually enhanced the participants’ appreciation of the effort required by older adults to complete activities of daily living when balance is challenged due to the ageing process. Fatigue could have further replicated the balance difficulties faced by older adults. However, given that there was only a slight reduction in BBS scores, which was the last test to be completed, it would suggest that this fatigue was not sufficient to have objectively influenced functional balance tasks in our sample.

**Conclusion**

This study has provided new data to support using the age suit as a simulation learning tool to experience some of the physical and physiological challenges that contribute to falls risk and challenges to balance faced by older adults on a daily basis. Gaining this simulated experience is recommended for people working with older adults in health and social care settings to enhance their empathy and insight into the challenges of ageing, with the intention of improving management and treatment for balance, falls risk and overall care.

**FIGURE LEGENDS**

Figure 1: The Adam, Rouilly AK060 age suit during performance of the FRT

Figure 2: boxplots to show distribution of Functional Reach Test (FRT) scores without-suit and with-suit scores for all participants (n=30)

Figure 3: boxplots to show distribution of Timed-up-and-go (TUG) scores without-suit and with-suit scores for all participants (n=30)

Figure 4: boxplots to show distribution of Berg Balance Scale (BBS) scores without-suit and with-suit for all participants (n=30).

**AUTHOR CONTRIBUTORSHIP**

Each author has made a substantial contribution to the design, data collection, analysis, and/or writing and revising the manuscript. Final approval of the version submitted for publication has been approved by each author, and each is in agreement with the accuracy of the data presented.

**COMPETING INTERESTS**

None declared.

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**ETHICS APPROVAL**

The study was approved by the academic institutions School Research Ethics Committee.

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