Does whole-body vibration training affect arterial stiffness, cognitive ability, and quality of life in chronic stroke?

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Abstract

Background: Stroke is a type of cardiovascular disease, which has the third highest mortality rate in New Zealand. Risk factors of stroke have major consequences on the structure and function of blood vessels and their interaction with circulating blood; altering vascular structure through encouraging atherosclerosis and stiffening of arteries and by inducing thickening, narrowing, and tortuosity of capillaries and arterioles. Additionally, research has reported that the most significant effect of a stroke for a survivor is a decline in health-related quality of life (HRQOL). Studies state that stroke is associated with increased arterial stiffness, and even once established, arterial stiffness can be diminished by a programme of physical activity. Whole-body vibration (WBV) is a safe, easy to use, and time effective exercise intervention that has demonstrated significant improvements in arterial stiffness in healthy men and older sedentary adults. Therefore, it is worthwhile to explore the possibility of WBV as a valuable intervention in chronic stroke.

Purpose: To investigate whether 4 weeks of WBV would significantly reduce indices of arterial stiffness, and improve cognition and quality of life in chronic stroke.

Methods: Six participants with chronic stroke volunteered for this study. This was a cross-over design, where participants were exposed to WBV training for 4 weeks (3 times a week) on a commercialised Galileo vibration machine with an oscillating platform. WBV parameters were progressed throughout the 4 week intervention (5-7 sets of 60 sec bouts with 60 sec rest, 22-26 Hz, 2.1-6.5 mm, static squatting), and a 2 week washout period was prescribed between WBV and control (usual day-to-day living for four weeks) interventions. Arterial stiffness measurements (carotid arterial stiffness, PWV, PWA), cognition (ACE-III), and quality of life (SF-36), were conducted prior to each intervention and after the completion of each intervention. Additionally, rate of perceived exertion (Borg 15-point scale) was also recorded following every WBV session.

Results: No significant improvements were shown for central BPs, HR, or central AIx@75. Additionally, no significant improvements were seen in PWV between WBV and control. There was not significant interaction, or main effects for carotid arterial stiffness (β), DC or CC. However, carotid arterial stiffness did display a decrease over time for WBV, where arterial stiffness increased for control over time, but these measurements and their interaction effect were not found to be significant ($p=0.166$). No significant interaction or main effects were found for quality of life (SF-36) or cognitive ability (ACE-III). Finally, there was no significance of RPE over the 4 weeks.

Conclusions: Limited studies have investigated the effects of multiple sessions of WBV (short-term training) in stroke, with no study examining the effects of WBV on arterial stiffness, QOL or cognition. The present study found no significant improvements in indices of arterial stiffness, cognitive ability, or QOL. However, this was the first study to investigate the effects of WBV on these variables in chronic stroke; therefore further research with larger sample sizes are needed to investigate the aims of this study further.

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Abbreviations

A

ACE-III	Addenbrooke's cognition examination
ACSM	American college of sports medicine
ADL	Activities of daily living
AIx	Augmentation index
AIx@75	Augmentation index at 75 beats per minute
AP	Augmentation pressure

B

β	Local arterial stiffness
BI	Barthel index
BP	Blood pressure
bpm	Beats per minute

C

°C	Degrees celsius
CC	Compliance coefficient
cDBP	Central diastolic blood pressure
CI	Confidence interval
cm	Centimetres
cms^{-1}	Centimetres per second
CNS	Central nervous system (check)
cPP	Central pulse pressure
CS	Canadian neurological scale
cSBP	Central systolic blood pressure

D

DBP	Diastolic blood pressure
DC	Distensibility coefficient
Ddia	Diastolic diameter
Dist	Distance between systolic diameter and diastolic diameter
Dsys	Systolic diameter

F

FP	Foot position

G

g	Gravitational acceleration

GOS	Glasgow outcome scale

H

HR	Heart rate
HRQOL	Health-related quality of life
HRR	Heart rate reserve
Hz	Hertz

K

kg	Kilograms

M

ms^{-2}	Metres per second squared
MAP	Mean arterial pressure
min	Minutes
mm	Millimetres
mmHg	Millimetres of mercury
MRI	Magnetic resonance imagining
mRS	Modified rankin scale
ms^{-1}	Metres per second

N

NIHSS	National institutes of health stroke scale
NO	Nitric oxide

P

PAR	Population attributable risk
PARQ	Physical activity readiness questionnaire
PP	Pulse pressure
PWA	Pulse wave analysis
PWV	Pulse wave velocity

Q

QOL	Quality of life

R

RM	Repetition maximum
ROM	Range of motion
RPE	Rate of perceived exertion
RS	Rankin scale

S

SAV	Side-alternating vertical sinusoidal vibration
SBP	Systolic blood pressure
SD	Standard deviation
sec	Seconds
SF-36	Short form-36
SSS	Scandinavian stroke scale
Sub	Subject
SV	Stroke volume
SV/PP	Stroke volume to pulse pressure ratio

T

TIA	Transient ischaemic attack
TUG	Timed up-and-go
TVR	Tonic vibration reflex

V

$\dot{V}O_2$	Volume of oxygen uptake
VV	Vertical synchronous vibration

W

WBV	Whole-body vibration

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