

ORIGINAL STUDIES

Modifications in plantar pressure in overground assisted gait training

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Abstract

Background. In recent years, gait rehabilitation research has focused on developing systems for central neurological diseases affecting the gait patterns of patients. However, most systems lack pelvis mechanisms that can control the rotational movements of the pelvis. RELIVE overground gait rehabilitation is a system designed to control obliquity.

Aims. This study investigates how the alternator - the RELIVE's subsystem that controls translational and rotational movement of the pelvis – influences gait in healthy subjects and is part of a more complex research.

Methods. The study took place in 2021 in the Elias Emergency University Hospital and 15 healthy subjects participated. We used in-shoe sensors from Tekscan, for gathering data regarding plantar pressure distribution, during various gait sessions with the RELIVE system. The gait sessions included walking with hands alongside the body, with the alternator turned on or off and with different degrees of body weight support. The gathered data was statistically analyzed with IBM SPSS Statistics v28 tool.

Results. When the alternator was turned on, the values of average plantar pressure decreased during the sessions characterized by walking hands free with the same percentage of body weight support. Statistically significant differences (p -value<0.05) were recorded comparing the gait sessions at 0 and 20% body weight offload. At 10% body weight offload, the differences were not statistically significant.

Conclusions. The results showed that the alternator subsystem might be able to offload the participant's weight to some extent. More investigations should be considered in the following studies, including more comparisons between other gait sessions.

Keywords: plantar pressure, gait rehabilitation, overground system, pelvic mechanism.

Introduction

Despite the significant progress in the prevention and treatment, stroke is still the second-leading cause of death and the third-leading cause of combined death and disability worldwide (Feigin et al., 2022). Conventional physiotherapy has limited success in recovering the loss of physical mobility for neurological patients. This is why, in recent years, a subject of interest is represented by novel therapy methods in gait rehabilitation, which imply using new technological solutions (Ye et al., 2014). Trunk and pelvis movements play an important role in achieving natural gait patterns. However, gait rehabilitation systems

lack an efficient pelvis mechanism, which can provide multiple degrees-of-freedom to control all six movements of the pelvis (Badea et al., 2021a).

In this context, the use of kinetic measurement systems has increased in the past years (Mann et al., 2016). Plantar pressure distribution is an important measure in the diagnosis of lower limb and gait conditions (Hessert et al., 2005) and it is also used for research purposes. Systems that record plantar pressure are platforms, plantar mats and in-shoe insoles. Platforms are limited to indoor measurement and although plantar mats have a large number of sensors for high accuracy measurements, they

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cannot be used for recording in various conditions, such as when using stairs (Ostaszewski et al., 2020). Another disadvantage of platform systems and mats concerns the sensors that get activated during walking, because they change with every step (Wafai et al., 2015).

By comparison, in-shoe insoles are more flexible, their main drawback being their fragility because they need to be very thin (Ostaszewski et al., 2020). These systems use the same sensors to measure the forces and pressures between the foot and the inside of the shoe. The main advantage of these systems is the possibility to record, average and analyze multi-steps within the same object or mask (Rosenbaum & Becker, 1997).

One of the most used in-shoe systems is F-Scan (by Tekscan, USA), which offers data acquisition straightaway with high resolution (Palaya et al., 2022; Woodburn & Helliwell, 1996).

RELIVE is an overground gait training system, which provides active movements for the pelvis. It was designed for rehabilitation in case of central neurological diseases, which affect the gait patterns of patients. The system has been studied intensively in the past years (Badea et al., 2021b; Seiciu et al., 2016; Ciobanu, 2016).

Hypothesis

RELIVE system has a subsystem for body weight support (BWS) and for vertical alternative oscillation of the pelvic girdle (or “alternator”). The alternator provides translational movement, as well as rotational (obliquity) of the pelvis during gait.

In this study we investigated how walking with hands alongside the body, with the alternator turned on, influences the average plantar pressure values.

Material and methods

Research protocol

a) Period and place of the research

The present study is part of a more complex research which investigates RELIVE system, some other experiments being previously published (Badea et al., 2022; Badea et al., 2021b). The research has the approval of the Ethics Committee of Elias Emergency University Hospital (6364/13.09.2021) and took place in the Physical Medicine and Rehabilitation Department, in 2021. The participants were enrolled after signing a consent form.

b) Subjects and groups

The study included 15 healthy, able-bodied subjects, both male and female, with no history of foot pain.

c) Applied tests

From the 16 possible gait sessions described in Table I, we have investigated only 6 sessions (C, E, G, I, K and M) having all the same characteristic: walking with hands free, alongside the body. Each participant had to walk three times during each gait session, summing a total of 18 walks.

Table I.
Gait sessions.

Gait sessions	Characteristics
A	Self-selected speed, without RELIVE
B	RELIVE speed, without RELIVE
C	Hands free, with RELIVE
D	Hands on handrail, with RELIVE
E	With alternator, hands free, with RELIVE
F	With alternator, hands on handrail, with RELIVE
G	With 10 % BWS, hands free, with RELIVE
H	With 10 % BWS, hands on handrail, with RELIVE
I	With 10 % BWS, with alternator, hands free, with RELIVE
J	With 10 % BWS, with alternator, hands on handrail, with RELIVE
K	With 20 % BWS, hands free, with RELIVE
L	With 20 % BWS, hands on handrail, with RELIVE
M	With 20% BWS, with alternator, hands free, with RELIVE
N	With 20% BWS, with alternator, hands on handrail, with RELIVE
O	RELIVE speed, out of RELIVE
P	Self-selected speed, out of RELIVE

Legend: BWS=body weight support

Plantar pressure data was collected during each walk, with F-scan from Tekscan (research software version).

In order to acquire the data needed for this study, we applied the peak/stance average function and obtained the average distribution of pressure values for each foot, during each walk. In order to analyze only complete stance phases, we deleted the first and the last recorded step. This way we eliminated the inaccuracies mentioned in previous studies, which occur during initiation and termination of gait (Patrick & Donovan, 2018).

In the end, we obtained the average distribution of pressure values for each foot, during each selected gait session C, E, G, I, K and M, by averaging the pressure values for the three walks within the same gait session.

d) Statistical processing

IBM SPSS Statistics v28 tool was used for statistical analysis. To verify that a variable is normally distributed, the Shapiro-Wilk test was used (given that we have less than 2000 records), with a p-value significance threshold of 0.05 (interpretation: if the p-value is above 0.05, then the data are considered as normally distributed). When one of the two variables compared was non-normally distributed, the corresponding non-parametric test was used.

Results

Table II shows the average plantar pressure obtained following the procedure described above, during sessions C and E.

We present below the results of the comparison of average plantar pressures between the two sessions, for each participant and the corresponding statistical significance.

Table II.
Session C vs. Session E.

Participant	Session C	Session E	p-value
Participant #1	98.7292	98.7917	0.971
Participant #2	102.0625	100.625	0.526
Participant #3	98.5625	96.375	0.623
Participant #4	101.375	99.7708	0.525
Participant #5	104.1667	95.8333	0.249
Participant #6	114.4375	93.5625	<0.001
Participant #7	107.6042	98.8958	0.057
Participant #8	112.5833	96.75	0.011
Participant #9	102.9583	97.7083	0.114
Participant #10	115.0208	93.7708	<0.001
Participant #11	106.2292	96.7917	0.047
Participant #12	114.5833	93.2083	<0.001
Participant #13	123.7708	102.9583	<0.001
Participant #14	114.6875	93.0208	<0.001
Participant #15	104.0208	85.2917	<0.001

Participant #1: From an average value of 98.7292 for Session C to an average value of 98.7917 for session E, the difference is not considered statistically significant: p-value = 0.971. Participant #2: From an average value of 102.0625 for Session C to an average value of 100.625 for session E, the difference is not considered statistically significant: p-value = 0.526. Participant #3: From an average value of 98.5625 for Session C to an average value of 96.375 for session E, the difference is not considered statistically significant: p-value = 0.623. Participant #4: From an average value of 101.375 for Session C to an average value of 99.7708 for session E, the difference is not considered statistically significant: p-value = 0.525. Participant #5: From an average value of 104.1667 for Session C to an average value of 95.8333 for session E, the difference is not considered statistically significant: p-value = 0.249. Participant #6: From an average value of 114.4375 for Session C to an average value of 93.5625 for session E, the difference is considered statistically significant: p-value <0.001. Participant #7: From an average value of 107.6042 for Session C to an average value of 98.8958 for session E, the difference is not considered statistically significant: p-value = 0.057. Participant #8: From an average value of 112.5833 for Session C to an average value of 96.75 for session E, the difference is considered statistically significant: p-value = 0.011. Participant #9: From an average value of 102.9583 for Session C to an average value of 97.7083 for session E, the difference is not considered statistically significant: p-value = 0.114. Participant #10: From an average value of 115.0208 for Session C to an average value of 93.7708 for session E, the difference is considered statistically significant: p-value <0.001. Participant #11: From an average value of 106.2292 for Session C to an average value of 96.7917 for session E, the difference is considered statistically significant: p-value = 0.047. Participant #12: From an average value of 114.5833 for Session C to an average value of 93.2083 for session E, the difference is considered statistically significant: p-value <0.001. Participant #13: From an average value of 123.7708 for Session C to an average value of 102.9583 for session E, the difference is considered statistically significant: p-value <0.001. Participant #14: From an

average value of 114.6875 for Session C to an average value of 93.0208 for session E, the difference is considered statistically significant: p-value <0.001. Participant #15: From an average value of 104.0208 for Session C to an average value of 85.2917 for session E, the difference is considered statistically significant: p-value <0.001.

In Table III are presented the average plantar pressures obtained following the procedure described above, during sessions G and I.

Table III.
Session G vs. Session I.

Participant	Session G	Session I	p-value
Participant #1	85.7083	80.6042	0.112
Participant #2	80.2708	75.6042	0.369
Participant #3	80.4792	77.8333	0.528
Participant #4	85.1875	73.6667	0.012
Participant #5	73.0625	71.1875	0.841
Participant #6	90.3125	71.0625	<0.001
Participant #7	87.1875	74.125	0.005
Participant #8	86.1875	74.6667	0.014
Participant #9	71.0417	72.6458	0.46
Participant #10	75.1875	71.4792	0.666
Participant #11	86.4375	75.3958	0.03
Participant #12	77.375	72.7292	0.57
Participant #13	84.7083	73.1042	0.041
Participant #14	90.5	76.2292	0.001
Participant #15	67.1458	74.8958	0.074

Below are the results of the comparison of average plantar pressures between the two sessions, for each participant and its statistical significance:

Participant #1: From an average value of 85.7083 for Session G to an average value of 80.6042 for session I, the difference is not considered statistically significant: p-value = 0.112. Participant #2: From an average value of 80.2708 for Session G to an average value of 75.6042 for session I, the difference is not considered statistically significant: p-value = 0.369. Participant #3: From an average value of 80.4792 for Session G to an average value of 77.8333 for session I, the difference is not considered statistically significant: p-value = 0.528. Participant #4: From an average value of 85.1875 for Session G to an average value of 73.6667 for session I, the difference is considered statistically significant: p-value = 0.012. Participant #5: From an average value of 73.0625 for Session G to an average value of 71.1875 for session I, the difference is not considered statistically significant: p-value = 0.841. Participant #6: From an average value of 90.3125 for Session G to an average value of 71.0625 for session I, the difference is considered statistically significant: p-value <0.001. Participant #7: From an average value of 87.1875 for Session G to an average value of 74.125 for session I, the difference is considered statistically significant: p-value = 0.005. Participant #8: From an average value of 86.1875 for Session G to an average value of 74.6667 for session I, the difference is considered statistically significant: p-value = 0.014. Participant #9: From an average value of 71.0417 for Session G to an average value of 72.6458 for session I, the difference is not considered statistically significant: p-value = 0.46. Participant #10: From an average value of 75.1875 for Session G to an average value of 71.4792

for session I, the difference is not considered statistically significant: p-value = 0.666. Participant #11: From an average value of 86.4375 for Session G to an average value of 75.3958 for session I, the difference is not considered statistically significant: p-value = 0.03. Participant #12: From an average value of 77.3750 for Session G to an average value of 72.7292 for session I, the difference is not considered statistically significant: p-value = 0.570. Participant #13: From an average value of 84.7083 for Session G to an average value of 73.1042 for session I, the difference is considered statistically significant: p-value = 0.041. Participant #14: From an average value of 90.5000 for Session G to an average value of 76.2292 for session I, the difference is considered statistically significant: p-value = 0.001. Participant #15: From an average value of 67.1458 for Session G to an average value of 74.8958 for session I, the difference is not considered statistically significant: p-value = 0.074.

Table IV shows the average plantar pressures obtained following the same procedure, during sessions K and M.

Table IV.
Session K vs. Session M.

Participant	Session K	Session M	p-value
Participant #1	66.6042	51.5625	<0.001
Participant #2	67.625	53.1458	<0.001
Participant #3	53.18421	50.0208	0.015
Participant #4	68.6042	53.5	0.002
Participant #5	60.4375	53.0417	0.126
Participant #6	65.1667	56.125	0.062
Participant #7	62.8333	55.5	0.24
Participant #8	64.8958	56.9792	0.035
Participant #9	61.375	52.625	0.359
Participant #10	70.75	53.3333	0.001
Participant #11	68.6458	54.6875	0.003
Participant #12	72.25	56.0417	0.002
Participant #13	61	51.25	0.003
Participant #14	70.5208	53.4792	<0.001
Participant #15	61.2083	52.9583	0.607

Below are the results of the comparison of average plantar pressures the two sessions, for each participant and its statistical significance:

Participant #1: From an average value of 66.6042 for Session K to an average value of 51.5625 for session M, the difference is considered statistically significant: p-value <0.001. Participant #2: From an average value of 67.625 for Session K to an average value of 53.1458 for session M, the difference is considered statistically significant: p-value <0.001. Participant #3: From an average value of 53.18421 for Session K to an average value of 50.0208 for session M, the difference is considered statistically significant: p-value = 0.015. Participant #4: From an average value of 68.6042 for Session K to an average value of 53.5 for session M, the difference is considered statistically significant: p-value = 0.002. Participant #5: From an average value of 60.4375 for Session K to an average value of 53.0417 for session M, the difference is not considered statistically significant: p-value = 0.126. Participant #6: From an average value of 65.1667 for Session K to an average value of 56.125 for session M, the difference is not considered statistically significant: p-value = 0.062. Participant #7: From an average value of 62.8333 for Session K to an average value of 55.5 for session M, the difference is not considered statistically significant: p-value = 0.24. Participant #8: From an average value of 64.8958 for Session K to an average value of 56.9792 for session M, the difference is considered statistically significant: p-value = 0.035. Participant #9: From an average value of 61.375 for Session K to an average value of 52.625 for session M, the difference is not considered statistically significant: p-value = 0.359. Participant #10: From an average value of 70.7500 for Session K to an average value of 53.3333 for session M, the difference is considered statistically significant: p-value = 0.001. Participant #11: From an average value of 68.6458 for Session K to an average value of 54.6875 for session M, the difference is considered statistically significant: p-value = 0.003. Participant #12: From an average value of 72.2500 for Session K to an average value of 56.0417 for session M, the difference is considered statistically significant: p-value = 0.002. Participant #13: From an average value of 61.0000 for Session K to an average value of 51.2500 for session M, the difference is considered statistically significant: p-value = 0.003. Participant #14: From an average value of 70.5208

Table V.
Session E vs. Session I vs. Session M.

Participant	Session E	Session I	Session M	p-value for E vs. I	p-value for E vs. M	p-value for I vs. M
Participant #1	98.7917	80.6042	51.5625	<0.001	<0.001	<0.001
Participant #2	100.625	75.6042	53.1458	<0.001	<0.001	<0.001
Participant #3	96.375	77.8333	50.0208	<0.001	<0.001	<0.001
Participant #4	99.7708	73.6667	53.5	<0.001	<0.001	<0.001
Participant #5	95.8333	71.1875	53.0417	<0.001	<0.001	<0.001
Participant #6	93.5625	71.0625	56.125	<0.001	<0.001	<0.001
Participant #7	98.8958	74.125	55.5	<0.001	<0.001	<0.001
Participant #8	96.75	74.6667	56.9792	<0.001	<0.001	<0.001
Participant #9	97.7083	72.6458	52.625	<0.001	<0.001	<0.001
Participant #10	93.7708	71.4792	53.3333	<0.001	<0.001	<0.001
Participant #11	96.7917	75.3958	54.6875	<0.001	<0.001	<0.001
Participant #12	93.2083	72.7292	56.0417	<0.002	<0.001	<0.001
Participant #13	102.9583	73.1042	51.25	<0.001	<0.001	<0.001
Participant #14	93.0208	76.2292	53.4792	0.024	<0.001	<0.001
Participant #15	85.2917	74.8958	52.9583	0.133	<0.001	<0.001

for Session K to an average value of 53.4792 for session M, the difference is considered statistically significant: p-value <0.001. Participant #15: From an average value of 61.2083 for Session K to an average value of 52.9583 for session M, the difference is not considered statistically significant: p-value = 0.607.

Lastly, the average plantar pressure of the participants during Sessions E, I and M have been compared (Table V).

Firstly, the result of the comparison between the values for Session E and I is presented:

Participant #1: From an average value of 98.7917 for Session E to an average value of 80.6042 for session I, the difference is considered statistically significant: p-value <0.001. Participant #2: From an average value of 100.625 for Session E to an average value of 75.6042 for session I, the difference is considered statistically significant: p-value <0.001. Participant #3: From an average value of 96.375 for Session E to an average value of 77.8333 for session I, the difference is considered statistically significant: p-value <0.001. Involving free hands and no BWS Participant #4: From an average value of 99.7708 for Session E to an average value of 73.6667 for session I, the difference is considered statistically significant: p-value <0.001. Participant #5: From an average value of 95.8333 for Session E to an average value of 71.1875 for session I, the difference is considered statistically significant: p-value <0.001. Participant #6: From an average value of 93.5625 for Session E to an average value of 71.0625 for session I, the difference is considered statistically significant: p-value <0.001. Participant #7: From an average value of 98.8958 for Session E to an average value of 74.125 for session I, the difference is considered statistically significant: p-value <0.001. Participant #8: From an average value of 96.75 for Session E to an average value of 74.6667 for session I, the difference is considered statistically significant: p-value <0.001. Participant #9: From an average value of 97.7083 for Session E to an average value of 72.6458 for session I, the difference is considered statistically significant: p-value <0.001. Participant #10: From an average value of 93.7708 for Session E to an average value of 71.4792 for session I, the difference is considered statistically significant: p-value <0.001. Participant #10: From an average value of 96.7917 for Session E to an average value of 73.3958 for session I, the difference is considered statistically significant: p-value <0.001. Participant #11: From an average value of 96.7917 for Session E to an average value of 73.3958 for session I, the difference is considered statistically significant: p-value <0.001. Participant #12: From an average value of 93.2083 for Session E to an average value of 72.7292 for session I, the difference is considered statistically significant: p-value = 0.002. Participant #13: From an average value of 102.9583 for Session E to an average value of 73.1042 for session I, the difference is considered statistically significant: p-value <0.001. Participant #14: From an average value of 93.0208 for Session E to an average value of 76.2292 for session I, the difference is considered statistically significant: : p-value = 0.024. Participant #15: From an average value of 85.2917 for Session E to an average value of 74.8958 for session I, the difference is not considered statistically significant: : p-value = 0.133.

Next, the values for session I and M are compared and

the results are as follows:

Participant #1: From an average value of 80.6042 for Session I to an average value of 51.5625 for session M, the difference is considered statistically significant: p-value <0.001. Participant #2: From an average value of 75.6042 for Session I to an average value of 53.1458 for session M, the difference is considered statistically significant: p-value <0.001. Participant #3: From an average value of 77.8333 for Session I to an average value of 50.0208 for session M, the difference is considered statistically significant: p-value <0.001. Participant #4: From an average value of 73.6667 for Session I to an average value of 53.5 for session M, the difference is considered statistically significant: p-value <0.001. Participant #5: From an average value of 71.1875 for Session I to an average value of 53.0417 for session M, the difference is considered statistically significant: p-value <0.001. Participant #6: From an average value of 71.0625 for Session I to an average value of 56.125 for session M, the difference is considered statistically significant: p-value <0.001. Participant #7: From an average value of 74.125 for Session I to an average value of 55.5 for session M, the difference is considered statistically significant: p-value <0.001. Participant #8: From an average value of 74.6667 for Session I to an average value of 56.9792 for session M, the difference is considered statistically significant: p-value <0.001. Participant #9: From an average value of 72.6458 for Session I to an average value of 52.625 for session M, the difference is considered statistically significant: p-value <0.001. Participant #10: From an average value of 71.4792 for Session I to an average value of 53.333 for session M, the difference is considered statistically significant: p-value <0.001. Participant #11: From an average value of 75.3958 for Session I to an average value of 54.6875 for session M, the difference is considered statistically significant: p-value <0.001. Participant #12: From an average value of 72.7292 for Session I to an average value of 56.0417 for session M, the difference is considered statistically significant: p-value <0.001. Participant #13: From an average value of 73.1042 for Session I to an average value of 51.2500 for session M, the difference is considered statistically significant: p-value <0.001. Participant #14: From an average value of 76.2292 for Session I to an average value of 53.4792 for session M, the difference is considered statistically significant: p-value <0.001. Participant #15: From an average value of 74.8958 for Session I to an average value of 52.9583 for session M, the difference is considered statistically significant: p-value <0.001.

Finally, the result of the comparison between the values for sessions E and M is presented:

Participant #1: From an average value of 98.7917 for Session E to an average value of 51.5625 for session M, the difference is considered statistically significant: p-value <0.001. Participant #2: From an average value of 100.625 for Session E to an average value of 53.1458 for session M, the difference is considered statistically significant: p-value <0.001. Participant #3: From an average value of 96.375 for Session E to an average value of 50.0208 for session M, the difference is considered statistically significant: p-value <0.001. Participant #4: From an average value of 99.7708 for Session E to an average value of 53.5 for session M, the difference is considered statistically significant: p-value

<0.001. Participant #5: From an average value of 95.8333 for Session E to an average value of 53.0417 for session M, the difference is considered statistically significant: p-value <0.001. Participant #6: From an average value of 93.5625 for Session E to an average value of 56.125 for session M, the difference is considered statistically significant: p-value <0.001. Participant #7: From an average value of 98.8958 for Session E to an average value of 55.5 for session M, the difference is considered statistically significant: p-value <0.001. Participant #8: From an average value of 96.75 for Session E to an average value of 56.9792 for session M, the difference is considered statistically significant: p-value <0.001. Participant #9: From an average value of 97.7083 for Session E to an average value of 52.625 for session M, the difference is considered statistically significant: p-value <0.001. Participant #10: From an average value of 93.7708 for Session E to an average value of 53.333 for session M, the difference is considered statistically significant: p-value <0.001. Participant #11: From an average value of 96.7917 for Session E to an average value of 54.6875 for session M, the difference is considered statistically significant: p-value <0.001. Participant #12: From an average value of 93.2083 for Session E to an average value of 56.0417 for session M, the difference is considered statistically significant: p-value <0.001. Participant #13: From an average value of 102.9583 for Session E to an average value of 51.2500 for session M, the difference is considered statistically significant: p-value <0.001. Participant #14: From an average value of 93.0208 for Session E to an average value of 53.4792 for session M, the difference is considered statistically significant: p-value <0.001. Participant #15: From an average value of 85.2917 for Session E to an average value of 52.9583 for session M, the difference is considered statistically significant: p-value <0.001.

Discussion

We compared all the gait sessions with RELIVE system that implied walking with hands free, alongside the body, with and without the alternator tuned on, at 0%, 10% and 20% body weight offload, corresponding to Sessions C, G, K, E, I, M in Table I.

When comparing Session C to Session E, for 9 out of 15 participants, statistically significant differences (p-value<0.05) were recorded regarding plantar pressure. When walking hands free, without any BWS and without the alternator turned on, the average pressure was higher than when walking hands free, without any BWS and with the alternator turned on. This result suggests that the alternator has an influence on the participant's body weight, being able to offload it to some degree.

When comparing Session G to Session I, for 7 out of 15 participants, statistically significant differences (p-value<0.05) were recorded regarding plantar pressure. For one participant the recorded difference was close to 0.05, but slightly higher (p=0.074) and it is not considered statistically significant. In this case, we cannot say that there are statistically significant differences in plantar pressure when walking hands free, with 10% BWS and without the alternator turned on versus walking hands free, with 10% BWS and with the alternator turned on. More

participants are required in order to clearly determine if a 10% BWS influences the differences between sessions.

When comparing Session K to Session M, statistically significant differences (p-value<0.05) were recorded regarding plantar pressure for 10 out of 15 participants. When walking hands free, with 20% BWS and without the alternator turned on, the average pressure was higher than when walking hands free, with 20% BWS and with the alternator turned on. The result of the comparison between Session K and Session M seconds the result of the first comparison, between Session C and Session E, emphasizing the fact that the alternator has influence on the participant's body weight.

When comparing Session E to Session I and Session M, the recorded difference was not statistically significant between Session E and I for only one participant. For the rest of the participants the difference between all sessions was statistically significant. This result implies that the BWS subsystem offloads efficiently the body weight of the participants, resulting in lower plantar pressure with each percentage of offload. Also, the alternator doesn't interfere, by reducing the offloading.

This study revealed that the alternator subsystem may play an important role in controlling the offload of the participant's weight. Thus, it has been emphasized that, when the alternator is turn on, the plantar pressure values have decreased during the sessions carried out with the RELIVE system in hands free condition, with the same percentage of BWS. This finding might be due to the fact that the alternator is part of the BWS subsystem. Another possible explanation is that the double support period is shortened, as many participants complained that they didn't have enough time to shift their center of gravity from one side to the other. Also, walking with hands alongside the body with the alternator turned on produces instability, the center of gravity often falling outside the base of support, which might reduce the average plantar pressure values.

Conclusions

1. The alternator subsystem might be able to offload the participant's weight to some extent. Plantar pressure values decrease during the sessions with the same percentage of BWS, when the alternator is turned on.

2. Other comparisons should be considered before stating a clear conclusion. It should be studied if and how walking with hands on the handrail differs from walking with hands alongside the body, with and without the alternator turned on, with different percentages of offload.

Conflicts of interest

Nothing to declare.

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