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Original article

Do rehabilitation patients with chronic low back pain meet World Health Organisation's recommended physical activity levels?

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ABSTRACT

Purpose: Primary: to analyse the time that patients with chronic low back pain (CLBP) admitted to pain rehabilitation spent on moderate to vigorous physical activity (MVPA) and compare this to the WHO recommendations. Secondary: to explore factors that might differentiate between those who do and do not meet the recommendations.
Materials and methods: A Cross-sectional study embedded in secondary interdisciplinary rehabilitation of adults with CLBP. PA was measured with a tri-axial accelerometer for 1 week during admission phase. Time spent in each PA level was calculated. MVPA was also analysed in ≥10 min bouts.
Results: Complete datasets of 4–6 days recorded accelerometery of n = 46 patients were analysed. Time spent in MVPA was on average 6.0% per day. MVPA per day in ≥10-min bouts occurred on average 0.8 times per day (sd = 0.9; min-max 0–4). Percentage of patients meeting the recommended level of MVPA was 21.7% (10/46) and 84.8% (39/46) for the 2010 and 2020 recommendations, respectively. Most demographic and clinical variables did not seem to differentiate between those who met the WHO recommendations, and those who did not.
Conclusion: The minority of the patients (22%) met the WHO recommended MVPA level of 2010. The more lenient recommendation of 2020 was met by 85%.

1. Introduction

In 2010, the world Health Organisation (WHO) recommended that adults aged 18–64 should perform throughout the week at minimum 150 min of moderate intensity aerobic physical activity (MPA), or at least 75 min of vigorous-intensity aerobic physical activity (VPA), or an equivalent combination of moderate- and vigorous-intensity activity (MVPA). These activities should occur in bouts of at least 10 min (https://www.who.int/teams/health-promotion/physical-activity/physical-activity-and-adults). The European Pain Association (EFIC) and the International Association for the Study of Pain (IASP) also recommend this for patients with chronic pain, including patients with chronic low back pain (CLBP). The WHO recommendations were updated in 2020 (https://www.who.int/teams/health-promotion/physical-activity/developing-guidelines-on-physical-activity-and-sedentary-behaviour), advising that adults should reach at least 150–300 min of MPA; or at least 75–150 min of VPA; or an equivalent MVPA throughout the week. Adults should also limit being sedentary, however, this recommendation is not quantified. An important update in the 2020 recommendation is the removal that MVPA activities should occur in bouts of ≥10 min. EFIC and IASP have not (yet) updated their recommendations to synchronize with the WHO 2020 recommendations.

The physical activity (PA) of patients with CLBP has been studied extensively, but the majority of studies were performed with questionnaires, which are insufficiently valid measures of MVPA (Carvalho et al., 2017; Geneen et al., 2017). An alternative is using accelerometers to quantify PA. Most studies that have used accelerometers focused on the difference of PA between patients and healthy controls, or the relationship between PA and pain or disability (Griffin et al., 2012; Hendrick et al., 2011; Spenkelink et al., 2002; Ryan et al., 2009; van den Berg-Emons et al., 2007; Lin et al., 2011; Oliveira et al., 2019), however, studies that specifically report MVPA are limited. A study in primary care reported an average MVPA of 21.7 min/day in adults with CLBP (Carvalho et al., 2017). Another study among teenagers with subacute or

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CLBP reported 82% spend in sedentary PA, 13% light PA, and 5% MVPA, with 56% meeting the teenagers recommendation of >30 min MVPA/-day (Leininger et al., 2017). Both studies did not report PA in bouts of ≥10 min. Despite these two studies, an overall paucity of research quantifying MVPA is observed. It is, therefore, unknown whether patients with CLBP meet the WHO 2010 or 2020 recommended MVPA.

For patients with CLBP admitted to pain rehabilitation, it is important to assess MVPA level because if insufficient, increasing MVPA towards WHO recommended levels could be one of the treatment goals. The evidence for a prognostic relationship between PA levels and pain and disability is limited, however, trends are indicative favouring more time spent in MVPA (Oliveira et al., 2019; Wood et al., 2021; Ryan et al., 2017; Hayden et al., 2020). The primary objective of this study was to analyse the amount of time that patients with CLBP, admitted for interdisciplinary pain rehabilitation, spent on MVPA and compare this to the WHO 2010 and 2020 recommendations. Knowing what factors differentiate between patients meeting MVPA recommendations and those who do not, may help clinicians in their choice towards more effective and efficient personalized treatment approaches. For example, a patient with catastrophizing beliefs may need a different approach compared to a depressed patient. Hence, the secondary objective was to explore factors that might differentiate between those who do or do not meet the WHO MVPA recommendations. Because of the exploratory nature of the secondary objective, a hypothesis was not formulated.

2. Methods

2.1. Design

This was a cross-sectional study embedded in the assessment phase of usual care interdisciplinary pain rehabilitation. For the present study, data were reused from a larger project performed in secondary and tertiary rehabilitation in The Netherlands (Ansuategui Echeita et al., 2020).

2.2. Participants

Participants were adults (between 18 and 65 years old) with CLBP as the primary diagnosis (ICD-11 code MG30.02) referred by a primary or secondary care physician, and admitted to secondary and tertiary rehabilitation. The main exclusion criteria were: specific cause of back pain, radicular pain in the legs, pregnancy, medical comorbidity affecting the study outcomes, and insufficient ability to speak or to understand instructions. Detailed in- and exclusion criteria are described elsewhere (Ansuategui Echeita et al., 2020). When patients fulfilled the criteria, they were informed about the primary study by the physician on their first visit to the centre and voluntarily signed the informed consent form. Ethical approval for the study was granted (METc, 2016/702).

2.3. Procedures

After inclusion, the occupational therapists of the pain rehabilitation team provided the accelerometer and instructed patients about its use during the first appointment of the rehabilitation program. Patients were instructed to continue their regular daily routines. It was advised to only remove the device during bathing and sleeping. To ensure that a minimum of four full days of measurement was collected, the device was worn for eight days including at least one weekend day (Trost et al., 2005; Migueles et al., 2017). After eight days, the subjects returned the device to the occupational therapists. Patients were blinded to the specific aim of this study, and they were not informed about the PA guidelines. Demographic and clinical variables were collected 1–2 weeks prior to accelerometer measurements. Hence all data was collected prior to the start of the rehabilitation program.

2.4. Variables

PA was measured with a tri-axial accelerometer, ActiGraph GT9X Link (ActiGraph, Pensacola, FL, USA), with a sampling frequency of 100 Hz. The ActiGraph device is small, 3.5x3.5 × 1 cm, weights 14 g, and was worn on the right hip either attached with a belt clip or with an elastic band, on the patient's preference. PA intensity was derived from the number and the magnitude of the accelerometer accelerations, as described in detail in the analysis section.

Demographic and clinical variables were collected by means of questionnaires. The questionnaires were filled in online. The Visual Analogue Scale (VAS) was used to express the pain intensity on a scale between 0 (no pain) and 10 (maximum pain imaginable)(Hawker et al., 2011). The Physical functioning subscale of the Rand36 (Rand36-PF) (van der Zee et al., 1996) was used to measure the health-related limitations patients experienced during daily activities. A higher total score (0–100) means better physical functioning. Pain Disability Index (PDI) was used to measure pain-related disability (Tait et al., 1990; Soer et al., 2013). The total score ranges from 0 to 70, where higher scores mean higher disability due to pain. The Work Ability Score (WAS) is a single-item question from the Work Ability Index (WAI), used to measure work ability (El Fassi et al., 2013). The WAS assesses the current work ability compared to the lifetime best (0–10). The Central Sensitisation CS Inventory part A (CSI-A; 0–100) was used to estimate the severity of the symptoms related to CS. A higher score represents more severe symptomatology (Mayer et al., 2012). Catastrophizing was measured with the Pain Catastrophizing Scale (PCS, 0–52) (Crombez and Vlaeyen, 1996). Injustice was measured with the Injustice Experience Questionnaire (IEQ, 0–48) (van Wilgen et al., 2014). Distress was measured with the Brief Symptom Inventory (BSI, global severity index t-score (GSIT), 0–100) (de Beurs and Zitman, 2006).

2.5. Analyses

Only days consisting of at least 10 h of accelerometer data were considered valid and hence included for analyses. The first and last days, when the device was provided and returned respectively, were excluded from analyses. Days with <600 min (10 h) wear time were considered invalid and coded as missing. Data of patients with a minimum of 4 valid days were included in the analyses.

PA intensity was derived from the magnitude of the accelerometer accelerations. From the acceleration of the 3 axes, the vector magnitude (VM) was calculated and expressed in counts ($VM = \sqrt{\text{axis1}^2 + \text{axis2}^2 + \text{axis3}^2}$). The VM was averaged per 1 min epoch (count per minute, (cpm)). The VM counts were used as an indicator of PA because of the direct relation with actual movement accelerations (de Beurs and Zitman, 2006).

The PA levels were classified in four cpm-based categories: sedentary (≤199 cpm), light (200–2689 cpm) (Aguilar-Far í as et al., 2014), and moderate (2690–6166 cpm) and vigorous (≥6167 cpm) (Sasaki et al., 2011). The time spent in each PA level was calculated for each day. MVPA data were analysed in bouts to enable comparison with the WHO 2010 recommendations. A bout of PA was defined and calculated as at least 10 min of continuous MVPA (sum of moderate and vigorous). Interruptions of <2 min were allowed to simulate real-life conditions such as slowing a run at a traffic light or stopping for water when walking (Ward et al., 2005). Customized codes to calculate bouts were made in Matlab (version R2018a; The Mathworks Inc., Natick, MA).

To analyse the percentage of patients that met the recommended level of MVPA, we calculated the daily amount of MVPA in ≥10-min bouts for every patient per day. The number of valid days varied between patients from 4 to 6 days. Therefore the 150 min MVPA as weekly criterion (WHO, 2010 and 2020) was divided by 7 days implying a recommended MVPA of at least 21.43 min a day in bouts of ≥10 min (WHO, 2010) or averaged per day (WHO, 2020).

To explore factors differentiating patients that met WHO criteria 2010 and 2020, and those who did not, descriptive statistics of the demographic and clinical variables were calculated for the group in total and for those meeting the criteria's separately. Because of the exploratory nature of these analyses, statistical testing was not performed. Descriptive statistics were calculated using IBM SPSS Statistics version 23 for Windows (SPSS, Chicago, IL, USA).

3. Results

Data were collected from September 2017 to June 2019. A total of 60 patients participated in the study, however, data of 10 patients were excluded because of technical issues while downloading, and 4 had less than 4 valid recording days. Consequently, data of 46 (76.6%) patients were used for PA analyses. Sensitivity analyses (not shown) revealed that missing data or missing days appeared random. Questionnaire data varied in completeness, resulting in clinical data varying between n = 36–46. The demographic and clinical characteristics of included patients are presented in Table 1.

Mean valid days was 5.5 days (sd 0.7, min-max 4–6). Total wear time over all valid days was mean 4689 min (sd 760), or 78.2 h, which equals to 14.2 h per day. The daily time spent in each PA level is presented in Table 2. The time spent in MVPA was mean 51.8 min (sd 28.7) or 6.0% per day. Time per day spent in MVPA ≥10-min bouts was mean 12.8 min (sd 16.4), and it occurred mean 0.8 times per day (sd 0.9; min-max 0–4). The percentage of patients meeting the recommended MVPA were 21.7% (10/46) and 84.8% (39/46) for respectively the 2010 and 2020 recommendations.

Results ofthe exploratory analyses are presented in Table 3. Most factors appear similar between those who meet the WHO 2010 and 2020 recommendations. The exceptions are that subjects meeting the WHO 2010 recommendations appear to have a lower pain duration, higher pain intensity and lower pain medication use.

Table 1
Demographic and clinical characteristics (n = 36–46) *.

	Mean (SD) or %
Age (y)	41.3 (12.4)
Gender male	37.0
Nationality Dutch	95.7
BMI (kg/m^2)	28.6 (5.5)
Work status	
Working	43.5
Reduced/adapted work	21.7
Work disability (temporary/permanent)	19.6
Other	15.2
Physical work demands (DOT)	
Sedentary	17.4
Light	43.5
Moderate	34.8
Heavy or very heavy	4.3
Education:	
Primary	2.2
Secondary	58.7
Bachelor or higher	39.1
Pain duration (y)	3.9 (4.7)
Pain Intensity (VAS, 0–10)*	5.4 (1.9)
Pain Disability (PDI, 0–70)*	30.8 (11.1)
Pain medication (yes)	73.9
Central Sensitisation (CSI, 0–100)**	38.2 (10.5)
Physical Functioning (Rand36-PF, 0–100)*	53.8 (21.5)
Pain Catastrophizing (PCS, 0–52)**	18.6 (10.2)
Perceived Injustice (IEQ, 0–48)**	16.5 (8.8)
Distress (BSI-GSIT, 0–100)	37.7 (6.7)
Workability (WAS, 0–10)	4.7 (2.3)

BMI, Body Mass Index; BSI-GSIT, Brief Symptom Inventory Global Severity Index T-score; CSI: Central Sensitisation Inventory; DOT: Dictionary of Occupational Titles; IEQ, Injustice Experience Questionnaire; PCS, Pain Catastrophizing Scale; PDI, Pain Disability Index; Rand36-PF, Physical Functioning; VAS, Visual Analogue Scale; WAS, Work Ability Score. *n = 36–37; **n = 43–45.

Table 2
Time spent in PA levels of patients with CLBP admitted to rehabilitation (n = 46).

	Minutes per day		Median (IQR)	% per day m (sd)
	Min-max	m (sd)		
PA level				
• Sedentary	254.6–666.5	461.0 (101.0)	458.3 (383.3–534.0)	54.9 (51.8)
• Light	201.8–559.8	331.9 (83.1)	308.3 (278.0–382.0)	39.1 (35.9)
• Moderate	10.5–120.2	49.4 (26.3)	45.7 (27.0–70.2)	5.8 (10.6)
• Vigorous	0.0–20.5	2.4 (4.5)	0.4 (0.4–2.0)	0.03 (1.6)

CLBP, chronic low back pain; PA, Physical Activity. m: mean; sd: standard deviation; IQR: interquartile range.

Table 3
Demographic and clinical characteristics of subjects meeting WHO criteria.

	All subjects (n = 36–46) Mean (SD) or %	**WHO 2010 (n = 6–10)** Mean (SD) or %	WHO 2020 (n = 30–39) Mean (SD) or %
Age (y)	41.3 (12.4)	44.8 (12.4)	40.4 (12.1)
Gender (% male)	37.0	50.0	43.6
Nationality Dutch (%)	95.7	100	94.9
BMI (kg/m^2)	28.6 (5.5)	26.8 (3.6)	28.0 (4.7)
Work status (%)			
Working	43.5	30	48.7
Reduced/adapted work	21.7	30	20.5
Work disability	19.6	20	18.0
Other	15.2	20	12.8
Physical work demands (DOT, %)			
Sedentary	17.4	20	15.4
Light	43.5	20	43.6
Moderate	34.8	50	35.9
Heavy or very heavy	4.3	10	5.1
Education (%):			
Primary	2.2	0	2.6
Secondary	58.7	60	56.4
Bachelor or higher	39.1	40	41.0
Pain duration (y)	3.9 (4.7)	2.5 (1.9)	4.2 (5.1)
Pain Intensity (VAS, 0–10)*	5.4 (1.9)	6.9 (1.0)	5.2 (1.9)
Pain Disability (PDI, 0–70)*	30.8 (11.1)	32.3 (13.0)	30.5 (11.0)
Pain medication (% yes)	73.9	50.0	69.2
Central Sensitisation (CSI, 0–100)**	38.2 (10.5)	40.4 (13.0)	39.1 (10.6)
Physical Functioning (Rand36-PF, 0–100)*	53.8 (21.5)	55.8 (20.8)	55.0 (20.8)
Pain Catastrophizing (PCS, 0–52)**	18.6 (10.2)	18.0 (7.1)	18.8 (10.5)
Perceived Injustice (IEQ, 0–48)**	16.5 (8.8)	13.3 (8.0)	16.6 (8.6)
Distress (BSI-GSIT, 0–100)	37.7 (6.7)	38.1 (7.9)	37.8 (7.0)
Workability (WAS, 0–10)	4.7 (2.3)	4.0 (2.5)	4.9 (2.4)

BMI, Body Mass Index; BSI-GSIT, Brief Symptom Inventory Global Severity Index T-score; CSI, Central Sensitisation Inventory; DOT, Dictionary of Occupational Titles; IEQ, Injustice Experience Questionnaire; PCS, Pain Catastrophizing Scale; PDI, Pain Disability Index; Rand36-PF, Physical Functioning; VAS, Visual Analogue Scale; WAS, Work Ability Score; WHO, World Health Organisation.*n = 36–37; **n = 43–45.

4. Discussion

Objective measurement of PA of patients with CLBP admitted to pain rehabilitation revealed that on average per day 6% of the wear time was spent in MVPA. A minority of the patients (22%) met the recommended MVPA level of the WHO 2010. The more lenient recommendation of WHO 2020 was met by 85% of the patients. The vast majority of MVPA was made up of moderate PA, and very little time in a vigorous PA level was observed (mean 0.03%). The amount of time spend sedentary was substantial (mean 54.9%). The WHO recommends to reduce time in

sedentary PA, but has not quantified their recommendation. Substituting time spent in sedentary PA for MVPA may have a positive prospective relationship (Ryan et al., 2017; Coelho Figueira Freire et al., 2022). Exploratory descriptive analyses revealed that most demographic and clinical variables did not seem to meaningfully differentiate between those who met the WHO criteria or those who did not, with possible exception of pain-related variables applied to the stricter 2010 criteria.

The difference between patients meeting the WHO 2010 or 2020 criteria is striking. This can be explained by the removal of the 10-min bout criterion in WHO 2020. Because most MVPA is spent in bouts of <10 min, 85% of the patients met the 2020 criteria. The PA criteria were developed within the context of general health, and from that perspective, there are good arguments to strive to meet or exceed these minimum recommendations. In this study, this would be applicable for 15% of the sample (based on the WHO, 2020 criteria). The time spent in sedentary PA was 55%, which is lower than those of teenagers (Leininger et al., 2017), but it is unknown how this should be interpreted within the WHO 2020 recommendation to 'reduce time spent in sedentary PA'. The WHO recommendations were, however, not designed for (prevention of) CLBP. A review on the relationship between measured PA and CLBP challenges the common notion that higher PA is associated with better prognosis of CLBP, while they found that more sitting during work reduced the risk of LBP (Ø ver å s et al., 2020). It was hypothesized that this finding was sample-specific, because it consisted of blue-collar workers which already had substantial PA. This illustrates that the relationship between PA and CLBP should be studied within the context of absolute values of PA. Theoretically, those whose PA is too high, should benefit from a decrease in their PA, and vice versa (Heneweer et al., 2009). Initial support for the beneficial effect of substitution of too much sedentary PA for high-intensity PA was observed from theoretical modelling, however, positive effects were observed in lower pain intensity only, but not in lower disability (Coelho Figueira Freire et al., 2022). We hypothesize that analysing PA data without the acknowledgement of subgroups with very high and very low PA levels might contribute to non-existing or small associations (Geneen et al., 2017; Ø ver å s et al., 2020). The secondary analyses in our study also seem to point in this direction, however, because sample sizes are too small to perform subgroup analyses, results must be interpreted cautiously. Additionally, although the reason is not yet understood, a distinction between work and leisure time (MV)PA seems relevant for LBP prevention and rehabilitation to reduce long term sickness absence risk (Gupta et al., 2021)

In the literature on PA in CLBP, one of the leading theories is based on avoidance-persistence behaviours (Hasenbring and Verbunt, 2010). While there is some evidence for this in self-report based studies, this is not confirmed by monitoring activities during daily life with accelerometry (Huijnen et al., 2011). Future studies that use accelerometer-based monitoring of PA intensities during daily life circumstances, in combination with clinical assessments, should be performed to unravel this relationship. Besides quantifying absolute values of PA intensities and distinctions between intensity levels, studies should also focus in more detail on transitions between PA intensity levels. Instead of mean PA levels, a detailed individualized PA intensity pattern over time may reveal more meaningful relations between PA and pain or other variables, including comorbidity, motor control, and psychological factors. These analyses are complex and contain large datasets, in terms of number of subjects and sampling time (a triaxial accelerometer with a sampling frequency of 100 Hz produces 300 data points per second) and require machine-leaning approaches that can extract patterns of PA intensities and transitions between these PA levels. Most Inertial Measurement Units (IMUs; activity monitors like ActiGraph), have embedded accelerometer and gyroscope sensors and a magnetometer, that can collect data at 100 Hz sampling frequency, which allows more detailed analysis of movement intensity patterns with pattern recognition approaches and analytical analyses, as shown recently by our study group (Zheng et al., 2022). The increase of availability of IMU; and activity monitors and software to analyse the data nowadays could ease the implementation of the devices in clinical practice, especially with smartphones and apps. This would provide low cost, wearable, unobtrusive devices that can be used to collect PA data before, during and after the treatment.

Missing PA data or missing days appeared random, which makes it unlikely that this has systematically biased the results of this study. As expected, patients did not wear the full week the accelerometer for at least 10 h. In order not to influence patients in their daily activities, they were not aware that they had to wear the device for at least 10 h (considered a valid day). Some patients forgot to recharge the device before the total depletion of the battery and, therefore, data collection was stopped which influenced the achievement of the valid days. In future studies a daily report/log of the activity and the wearing time will provide additional information about reason of missing data. Future PA studies should also consider the interpersonal variability and include a larger sample to better grasp the multifactorial aspect of CLBP and its relation with PA. In the present study, data collection was integrated in care as usual, which means that patient selection in this study generalizes well to Dutch secondary rehabilitation (K ö ke et al., 2017), but not to primary care or patients who do not seek care. A cross sectional design was applied, and claims about cause and effect should not be based on this study. In line with preliminary studies by others (Ryan et al., 2017; Coelho Figueira Freire et al., 2022), a very relevant direction of future research to be considered in a longitudinal design would be to study replacement of sedentary PA time for MVPA time in patients with CLBP and an overrepresentation of sedentary PA. Although some variables seem to differentiate between those who met the WHO recommendations and those who did not, our study was clearly underpowered to examine these differences or relations in more detail, using for instance multivariate regression. No a priory sample size was set for the present study, because the data was collected for a different purpose. The sample size, however, was adequate for the first research question, but not for the second. However, the information was presented to enable others to calculate adequate sample sizes for future studies that address objectives such as our secondary question.

To our knowledge, this study is the first to report on the time patients with CLBP admitted to rehabilitation spent in MVPA, and how this related to the WHO recommendations. The PA criteria were developed within the context of general health, but not for (prevention of) CLBP. To further unravel the relation between (MV)PA and CLBP, future accelerometer-based research is needed in large samples, as well as the application of machine-leaning analytical approaches that can extract patterns of PA intensities and transitions between these PA levels at more detailed levels.

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Author contributions

All authors discussed the results and commented on draft manuscripts and approved the final the manuscript. MR: conception, preparation, analyses, interpretation, writing. JAE: preparation, data collection, interpretation, editing. KK: analyses, interpretation, editing HRSP: conception, preparation, interpretation, editing. RD: interpretation, editing. CJCL: analyses, interpretation, editing.

Declaration of competing interest

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