

https://dspace.org/

Slow and steady but not related to HIV stigma: physical activity in South Africans living with HIV and chronic pain

Wadley, Antonia; Kamerman, Peter; Pincus, Tamar; Evangeli, Michael; Chinaka, Tapiwa ...

2022-11
Springer
https://hdl.handle.net/10539/50230
Wadley, A., Kamerman, P., Pincus, T., Evangeli, M., Chinaka, T., Francois Venter, W. D., Akpomiemie, G., Moorhouse, M., & Parker, R. (2023). Slow and Steady But Not Related to HIV Stigma: Physical Activity in South Africans Living with HIV and Chronic Pain. AIDS and behavior, 27(6), 1950–1961. https://doi.org/10.1007/s10461-022-03928-7

Downloaded from a DSpace repository. https://dspace.org/

AIDS and Behavior (2023) 27:1950–1961
https://doi.org/10.1007/s10461-022-03928-7

ORIGINAL PAPER

Slow and Steady But Not Related to HIV Stigma: Physical Activity in South Africans Living with HIV and Chronic Pain

Antonia Wadley[1] · Peter Kamerman[1] · Tamar Pincus[2] · Michael Evangeli[2] · Tapiwa Chinaka[1] · W. D. Francois Venter[3] · Godspower Akpomiemie[3] · Michelle Moorhouse[3] · Romy Parker[4]

Accepted: 6 November 2022 / Published online: 27 November 2022
© The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2022

Abstract

HIV stigma may influence physical activity in people living with HIV (PLWH) and chronic pain. We prospectively examined the relationship between stigma, activity and chronic pain in a convenience sample of PLWH initiating antiretroviral therapy in an inner-city clinic in Johannesburg, South Africa. Participants wore accelerometers to measure daily duration and intensity of activity for 2 weeks. Stigma was assessed with the Revised HIV Stigma Scale. Participants [n = 81, 89% female, age mean (SD) 42 (8)] were active for a median of 7 h daily (IQR 5.2, 9.2), but at very low intensity, equivalent to a slow walk [median (IQR): 0.39 m s^{-1} (0.33, 0.50)]. Duration and intensity of activity was not associated with stigma, even after controlling for age, self-assessed wealth, pain intensity and willingness to engage in physical activity (p-values > 0.05). As stigma did not associate with greater activity, drivers of sustained activity in South African PLWH remain unclear.

Keywords HIV · Pain · Physical activity · Stigma · Africa

Resumen

El estigma del VIH puede influir en la actividad física de las personas que viven con el VIH (PVVS) y el dolor crónico. Se examinó prospectivamente la relación entre el estigma, la actividad y el dolor crónico en una muestra de conveniencia de PVVS que iniciaba la terapia antirretroviral en una clínica del centro de la ciudad en Johannesburgo, Sudáfrica. Los participantes usaron acelerómetros para medir la duración diaria y la intensidad de la actividad durante dos semanas. El estigma se evaluó con la escala revisada de estigma del VIH. Los participantes [n = 81, 89% mujeres, media de edad (SD) 42 (8)] tenían una actividad de intensidad muy baja, para una mediana de siete horas diarias (IQR 5.2, 9.2), pero, equivalente a una marcha lenta [mediana (IQR): 0.39 m s^{-1} (0.33, 0.50)]. La duración y la intensidad de la actividad no se asociaron con los niveles de estigma, incluso después de controlar la edad, la riqueza autoevaluada, la intensidad del dolor y la voluntad de participar en la actividad física (valores de p > 0.05). Como el estigma no se asoció con una mayor actividad, los impulsores de la actividad sostenida en las PVVS sudafricanas siguen sin estar claros.

Introduction

Pain continues to be experienced by over half of people living with HIV (PLWH) despite widespread rollout of antiretroviral therapy (ART) programmes and use of significantly less neurotoxic ART [1, 2]. The most likely root cause of pain in PLWH is HIV-associated inflammation [3–5]. Additionally psychosocial factors, such as low socioeconomic status [6], that make people susceptible to contracting HIV may also put them at risk for developing chronic pain [6].

Chronic pain, defined as pain that has been experienced on most days for more than 3 months [7], is associated with poor mental health and reduced quality of life [8].

✉ Antonia Wadley
antonia.wadley@wits.ac.za

1 Brain Function Research Group, School of Physiology, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

2 Department of Psychology, Royal Holloway University of London, Egham, UK

3 Ezintsha, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

4 Pain Management Unit, Department of Anaesthesia and Perioperative Medicine, Faculty of Health Sciences, University of Cape Town, Cape Town, South Africa

Chronic pain is also associated with reduced activity in PLWH [9, 10]. Indeed, the association between pain and reduced activity is relatively clear in most pain populations including those living with pain and HIV in high income countries [10–12]. Some studies from Africa, however, have not reported a reduction of activity in the presence of chronic pain [13, 14], but these studies measured activity subjectively. To investigate this contradiction in associations between pain and activity, we measured activity objectively in a cohort of South African PLWH, and found that pain intensity did not predict activity and furthermore, there was no difference in duration or intensity of activity between those with and without chronic pain [15].

Further data from our earlier study highlighted that there may be cultural factors influencing the relationship between pain and activity. For example, in addition to younger age, unemployment and greater concern about food, predicted greater activity in multivariate analysis. These associations with economic factors are in the South African context of unemployment levels of 44%, with only a third receiving any form of state financial support, and only 5% of those with chronic pain receiving a state disability grant [15]. Grants typically support an entire household, not just the recipients [16]. Furthermore, qualitative data from the earlier study suggested that a proportion of participants had not told their family or friends about their pain for fear that any appearance of being 'sick' would reveal their HIV status, suggesting a role of HIV stigma in the pain experience of people living with both HIV and chronic pain [15]. Indeed, in a small follow-up study of South African PLWH and chronic pain, HIV stigma was associated with both pain intensity and depression [17].

We explored duration and intensity of activity using more detailed intensity measurements and in a larger sample, with a view to informing culturally-relevant pain management programmes, which typically encourage increased physical activity. We hypothesised that greater HIV stigma would be associated with longer duration and higher intensity activity as people were motivated to appear healthy and hide their HIV status.

Methods

The study received ethical clearance from the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (clearance no: M170560).

Data collection took place from September 2017 to February 2020. All participants had a confirmed diagnosis of HIV, were ≥ 18 years old and had chronic pain, defined as a history of pain on most days of the week for at least the last 3 months [7]. Participants were recruited from the waiting area of a clinical trials unit in the inner-city of Johannesburg, South Africa. Most of the participants (80%) were part of a clinical trial (ADVANCE, ClinicalTrials.gov identifier: NCT03122262), the results of which have been published elsewhere [18]. In brief, the trial was a 96-week, phase 3 trial comparing three commonly used first-line antiretroviral drug regimens for the treatment of HIV infection.

Here we describe a primary analysis of data from a prospective, cross-sectional study.

Questionnaires

We have found previously that individuals entering our studies are comfortable, second-language English speakers. English questionnaires were administered by a research assistant who is fluent in commonly spoken local languages including isiZulu, isiXhosa and Ndebele, who could translate terms as and when needed.

Pain Intensity

Pain intensity was measured using the Brief Pain Inventory (BPI) [19]. Participants were asked to report the intensity of their pain when it was at its worst, its least, and the average pain in the past week, and the intensity of their pain at the time of assessment. Each rating was made on an 11-point numerical rating scale anchored at 0 ("no pain") and 10 ("the worst pain you can imagine"). A pain severity score was calculated by taking the average of the four measurements. The BPI has been extensively used in the study of pain in South African PLWH [20, 21].

HIV Stigma

The 32-item revised version of the HIV Stigma Scale (HSS) was used to measure stigma associated with having HIV [22, 23]. For example, one statement says "I worry people who know I have HIV will tell others". For each item, participants recorded their response on a four-point Likert scale anchored at 1 ("strongly disagree") and 4 ("strongly agree"). The total score, which includes two reverse-coded items (8 and 18), was calculated by adding the item scores, giving a total score that ranged from 32 to 128, with a greater score indicating greater perceived HIV stigma.

Social Support

The Medical Outcomes Social Support Survey (MOSS) was used to measure social support [24]. Participants are asked how often different forms of social support are available to them, such as "someone you can count on to listen to you when you need to talk". The instrument consists of 19 items each rated on a five-point Likert scale anchored at 1 ("Not at all") and 5 ("All of the time"). The overall score was

calculated by averaging across the 19 item scores, giving a value from 1 to 5, with greater values indicating greater social support.

Pain Acceptance: Willingness to Engage in Activities

Willingness to engage in activities despite pain was assessed using the four-item willingness subscale of the Chronic Pain Acceptance Questionnaire-8 (CPAQ) [25]. Participants scored each item on a seven-point Likert scale anchored at 0 ("Never true") and 6 ("Always true"). One example of a statement is "I avoid putting myself in situations where my pain might increase". Item scores were reverse scored and then added to arrive at a score ranging from 0 to 23, with greater scores indicating greater willingness to engage in activities. The pain willingness subscale has been used in another study investigating pain acceptance in PLWH who had chronic pain [26].

Self-rated Wealth

We previously reported that PLWH in our environment are impacted by poverty, such that food insecurity was associated with greater physical activity [15]. However, we are unaware of any scales that have been developed for the self-assessment of financial security in a low or middle income country. We therefore developed a simple categorical scale asking participants to rate their wealth based on whether their financial needs were being met. Participants were given four options to rate their wealth. The options were: "Not enough money for basic things", "Money for food and clothes, but short on many other things", "Have most important things, but only a few luxury goods", and "'Money for extra luxury things". The statements were deliberately vague, leaving each respondent to interpret the statements, based on what they believed was their financial situation. No individuals chose the "Money for extra luxury things" category. The assessment has face validity, and based on a positive association between employment status (unemployed, part-time work, full-time work) and self-rated wealth assessment, we believe that the assessment has good convergent construct validity [χ^2 values > 36 and simulated p-values < 0.001 for the original dataset and all five datasets with imputed missing values (see "Data Processing and Analysis" section below)].

Depression

The Patient Health Questionnaire 9 (PHQ-9) [27] was used to measure depression. Participants responded to the nine items on a four-point Likert scale anchored at 0 ("Not at all") and 3 ("Nearly every day"). The rating for each item was summed to arrive at a total score that ranged from 0 to 27, with a greater score indicating greater depressive symptoms. The PHQ-9 does not contain questions about presence of pain as many depression tools do, and has been found to be a reliable tool in South African chronic care settings including HIV [28, 29].

Anxiety

The ten-item anxiety subscale of the Hopkins Symptom Checklist-25 was used to assess anxiety [30]. Participants rated how much they were bothered by symptoms of anxiety using a four-point rating Likert scale anchored at 1 ("not at all") and 4 ("extremely"). Participants' responses to the ten questions were averaged. The English language version of the Hopkins Symptom Checklist-25 has been validated in a cohort of South African PLWH and pain, who spoke English as a second language [31].

Accelerometry

Participants wore an accelerometer (Actical, Respironics, OR, USA) on their waist for 2 weeks to measure physical activity. Each accelerometer weighed approximately 22 g, measured $29 \times 37 \times 11$ mm, and was fitted on a belt. Participants were instructed to only remove the accelerometer for showering, bathing or swimming.

Data Processing and Analysis

All data processing and analysis was performed in the R statistical environment (v4.1.2) [32], using the following packages: broom [33], dplyr [34], flextable [35], forcats [36], geomtextpath [37], ggplot2 [38], gtsummary [39], janitor [40], kableExtra[41], lubridate [42], mgcv [43], mice [44], parameters [45], patchwork [46], performance [47], purr [48], readr [49], readxl [50], skimr [51], stringr [52], tibble [53], tidyr [54], vcdExtra [55]. All data, analysis scripts and analysis script outputs are available at Zenodo: https://doi.org/10.5281/zenodo.6631582.

Participants

Figure 1 shows the loss of activity data from participants through the process of data cleaning and accelerometer calibration. Briefly, 151 participants were recruited and had activity data downloaded. Of the 151 participants, 33 had accelerometers that could not be calibrated because the accelerometers were later stolen from the office of one of the investigators and we conducted our calibration at the end of the study. Data from these 33 participants was therefore excluded from further analysis. A further 24 participants' accelerometers were calibrated, but the calibration curves indicated poor characteristics at low speeds and data from

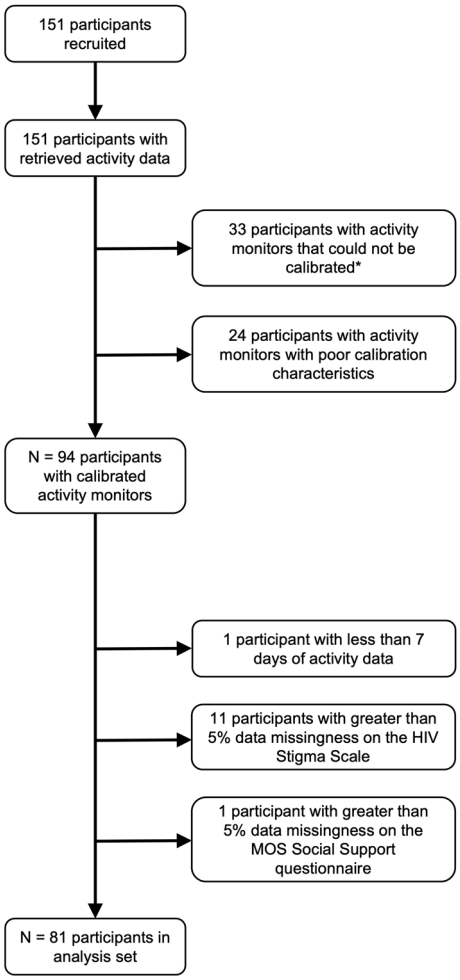


Fig. 1 Flow diagram of activity data inclusion through the process of data cleaning and calibration. *Accelerometers were stolen from an investigator's office after data were retrieved and downloaded, but before calibration took place

these participants' data were excluded from analysis. Of the remaining 94 participants with calibrated accelerometer data, data from 13 participants were excluded for a variety of reasons (1 for having > 5% missing data on the MOS Social Support questionnaire, 1 for having less than 7 days of activity recording, and 11 for have > 5% missing data on the HIV Stigma Scale), leaving data from 81 participants in the final analysis set. There was minimal data missingness from the questionnaires in the remaining 81 participants (missingness < 3%), and these missing data were imputed using multivariable imputation via chained equations, with 5 imputations.

Comparisons between the 81 participants included in the final analysis set (i.e., participants with calibrated loggers, ≥ 7 days of activity data, and < 5% missingness on all questionnaires) and a comparable group of the 40 participants who had been excluded because of lack of calibrated activity measurement, but who also had ≥ 7 days of activity data and < 5% missingness on all questionnaires showed no meaningful differences between the two groups for any of the outcome measures (Supplements 1–7).

Accelerometer Calibration

To account for variability in recording thresholds and sensitivity of the accelerometers, all loggers that had not been stolen were calibrated. The calibration involved an investigator (AW) wearing the accelerometers while walking at increasing speeds on a treadmill (1.0, 1.5, 2.0, 3.0, 3.5, 4.0, 5.0, 6.0, 10.0 km h^{-1}) for 3 min at each speed. Using the average of the accelerometer count from the last minute of each 3-min period, a calibration curve of speed versus activity count was constructed using a general additive model with a thin-plate spline (Supplement 8). The calibration equations were then used to calculate the pace (intensity) of movement by participants in m s^{-1}. Because of the location of the accelerometers (worn on the hip), we assumed that the majority of activity recordings would be recording ambulation.

Analysis of the Primary Objective

Figure 2 shows the framework that informed our analysis plan [56]. Based on our previous observations, we hypothesised that stigma would have a direct effect on physical activity, and, because of associations between perceived stigma and depression and anxiety [57] we hypothesised that stigma may also have an effect on physical activity mediated by depression and anxiety (variables known to affect physical activity [58–60]. In addition, we set pain intensity, willingness to engage, age, and self-rated wealth to be covariates. We theorised that social support, while possibly interacting with perceived stigma, was probably not causally linked to physical activity.

We chose two measures of physical activity as outcome variables, namely, median daily duration of activity (i.e., for how long was each participant active per day, irrespective of the intensity of that activity), and median pace of activity when active (i.e., what was the intensity of the movement when active).

The first part of the analysis involved plotting all the independent variables against duration of activity and intensity of activity. Where there were missing data for a variable, the missing values were imputed (see above), and bivariate plots were constructed for the original dataset (with pairwise deletion where there were missing observations), and for each of the five complete (imputed values) datasets. Thereafter a linear regression model was generated between perceived stigma and each of the two outcome variables (duration and intensity of activity). We also generated full models with stigma and the other covariates shown in Fig. 2

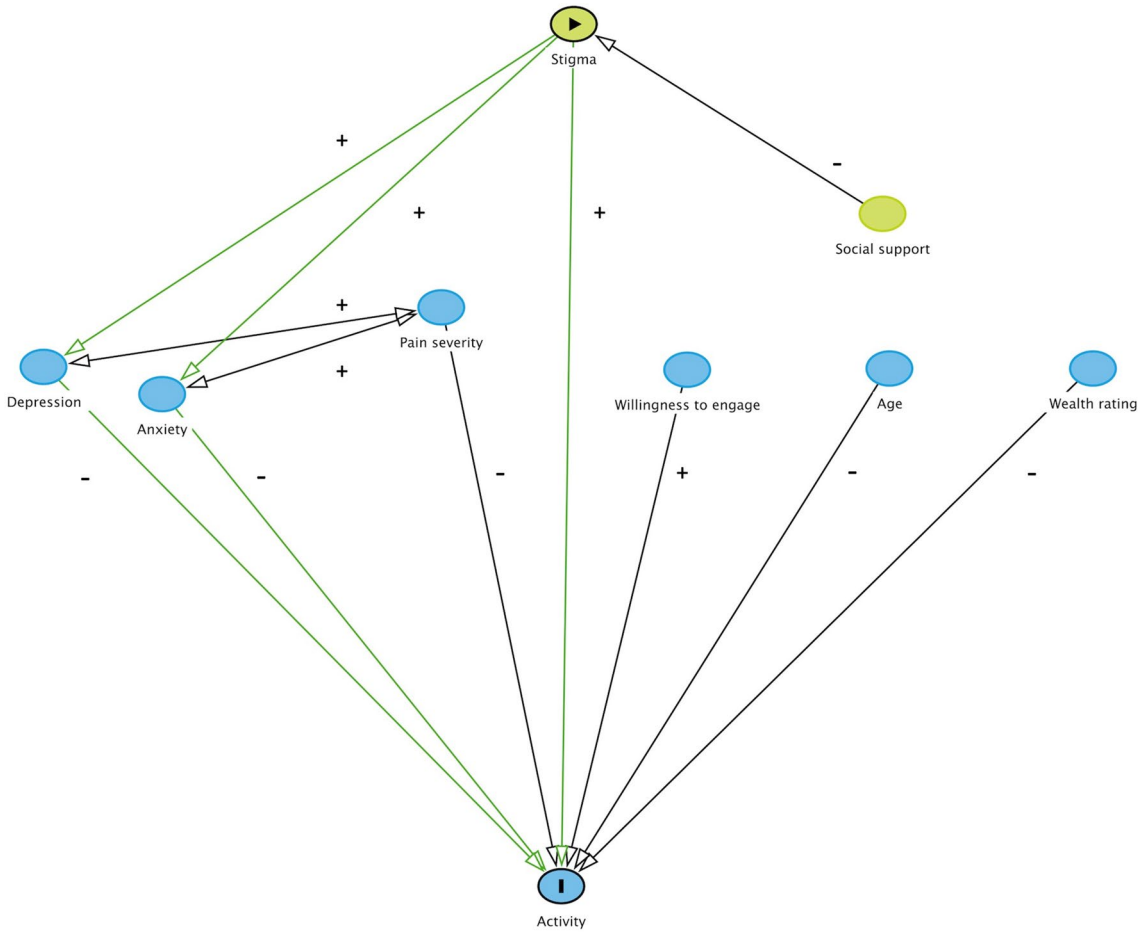


Fig. 2 Theoretical framework that underpinned the analysis. Proposed positive (+) and negative (−) associations

(pain intensity, age, willingness to engage, and self-rated wealth). Models were generated using the original dataset, with list-wise deletion of variables where there were missing values, and the imputed datasets. For the imputed datasets, a separated regression was run on each dataset and the results were pooled into a single, unified model. We made our interpretations based on the results of the pooled models for all models. Those interpretations were based not only on the p value but also on the magnitude of the effect size as given by the 95% confidence intervals of the estimates.

Results

Details of the performance of the questionnaires are in the supplementary material. In short, the internal consistency of the questionnaires was as follows [Cronbach alphas (95% confidence interval): HIV stigma scale 0.92 (95% CI 0.9–0.94), Medical Outcomes Social Support Survey 0.96 (95% CI 0.95–0.97), Pain acceptance: Willingness to engage subscale 0.63 (95% CI 0.53–0.72), PHQ-9 for depression 0.76 (95% CI 0.7–0.82), HSCL-25 anxiety subscale 0.84 (95% CI 0.81–0.88)].

Table 1 shows the baseline characteristics of the analysis set before imputation (see Supplement 9 for versions of the table generated for the five imputed datasets). The majority of the participants were female, had secondary school education, and were employed either full time or part-time/piece work. While the unemployment rate was roughly one-third, over 50% of participants indicated that they did not have enough money for basic things. Participants had low CD4 T-cell counts and high viral loads, which was to be expected as they had recently started, or were just about to start, ART. The duration of time on ART for the 17 patients not in the clinical trial is unknown. On average, pain was of moderate intensity, and willingness to engage in physical activity was low. There was a moderate level of perceived stigma, low levels of depressive symptoms, and moderate levels of anxiety. The presence of social support was rated very high.

Table 1 Summary of demographic and questionnaire data

Characteristic	N = 81*
Body mass index (kg m^{-2})†	24 (20, 28)
CD4 T-cell count (cells mm^{-3})†	296 (214, 496)
HIV viral load (RNA copies ml^{-1})†	19,178 (4889, 58,401)
Age (years)	42 (38, 47)
Sex	
Female	72 (89%)
Education	
Primary: grade 1–7	5 (6.2%)
Secondary: grade 8–12	69 (85%)
Higher education	7 (8.6%)
Employment	
Full time	41 (51%)
Part time/piece work	14 (17%)
Unemployed	26 (32%)
Proportion of household members that earn an income	0.33 (0.25, 0.50)
Self-assessment of wealth	
Have most important things but few luxury goods	4 (5.1%)
Money for food and clothes, but short on many other things	33 (42%)
Not enough money for basic things	42 (53%)
(Missing)	2
BPI: pain severity (score range: 0–10)	4.80 (4.01, 5.43)
CPAQ-8: willingness to engage subscale (score range: 0–24)	2.00 (0.00, 4.25)
(Missing)	1
HSS: stigma (range: 32–128)	86 (75, 90)
(Missing)	13
PHQ-9: depression (range: 0–27)	6.5 (3.0, 11.0)
(Missing)	1
HSCL-25: anxiety subscale (range: 1–4)	1.70 (1.30, 2.10)
(Missing)	1
MOSS: social support (range: 1–5)	4.84 (3.95, 5.00)
(Missing)	1

*n (%); Median (IQR)

†Baseline data from ADVANCE trial participants only (n = 64)

Activity Levels

The top panel on Fig. 3 shows the mean and interquartile of the median daily duration of activity, and the bottom panel shows the median and interquartile range of the intensity of activity, when active. The accelerometers were triggered between 0.28 and 0.42 m s^{-1} (1.0–1.5 km h^{-1}), which equates to being mobile, but at a pace slower than a 'slow walk' [61]. The median time active for the group as a whole was 7.2 h per day (IQR 5.2–9.2), but there was significant variability in the median time active per day across participants such that one participant was active for a median of 0.2 h per day while another was active for a median of 14.3 h per day. Some participants showed high levels of inter-day duration of activity (up to about 14 h), which was unaccounted for by employment status or type of job. The median intensity of activity was low for the group as a whole, and there was very little variation across the group of participants [median: 0.38 m s^{-1} (IQR 0.36–0.42)]. The median intensity of activity for all individuals was below the pace of a slow walk (0.82 m s^{-1}) [61].

Figure 4 shows the relationship between duration of activity and pace when active. There was no apparent relationship between the two measures of activity. That is, the two variables were independent of each other.

Univariate Analysis

Univariate plots of the covariates (perceived stigma, pain intensity, age, willingness to engage, and self-rated wealth) and the two potential mediators (depression and anxiety) versus duration of activity are presented in Supplement

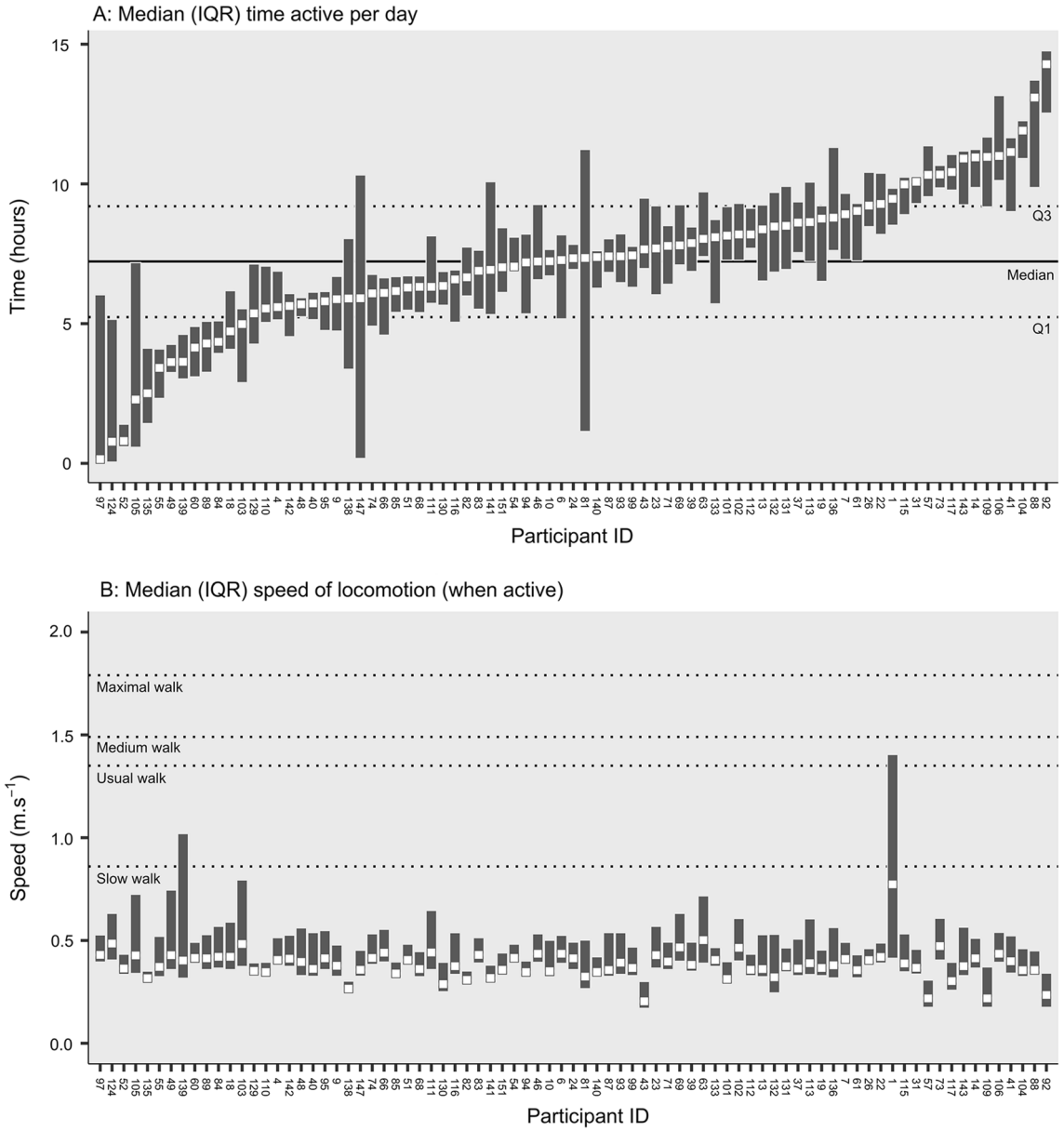


Fig. 3 Median (interquartile range, IQR) time active per day (**A**) and speed of locomotion when active (**B**) for each participant. The solid horizontal line in **A** shows the median time active for the cohort, while the dotted lines show the first (Q1) and third (Q3) quartiles for the time active for the cohort. The dotted horizontal lines in **B** show the pace (slow walking speed through to maximal walking speed) based on Murtagh et al. [61]

10, while univariate plots of the independent variables and the two potential mediators versus intensity of activity are presented in Supplement 11. None of the plots displayed a clear positive or negative relationship between any of the independent variables and the two measures of activity, and so no univariate modelling was performed, except to assess the primary hypothesis that increased stigma was associated with an increase in activity, measured here as duration of activity and median pace of activity. Perceived stigma was not associated with either outcome measure [(duration of activity, Supplement 12) and (intensity of activity, Supplement 13)].

Multivariable Analysis

The results of the full models (stigma, pain, age, willingness to engage, and self-rated wealth versus the two measures of activity) are shown in Tables 2 (also Supplement 12) and 3 (also Supplement 13). No meaningful relationships were detected.

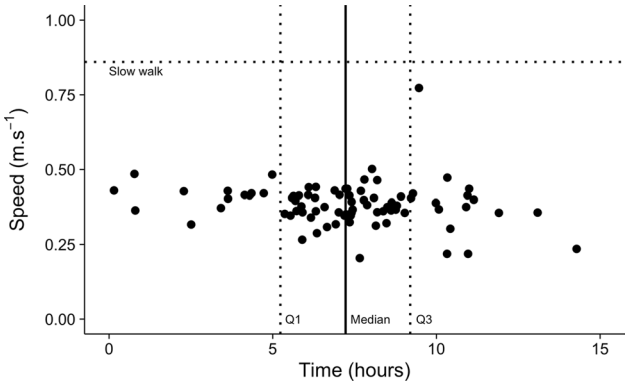


Fig. 4 Speed of locomotion when active versus daily active time. Points are median values for individuals. The solid vertical line shows the median time active for the cohort, while the dotted lines show the first (Q1) and third (Q3) quartiles for the time active for the cohort. The dotted horizontal line shows the pace (slow walking speed) based on Murtagh et al. [61]

Discussion

In this study we explored activity in PLWH and chronic pain, and factors that predicted that activity. We investigated activity in two ways: time spent active per day and intensity of that activity. We found that individuals were active for a median of 7 h a day, but that activity was very low intensity. That is, participants moved at or below the equivalent of a slow walk for the majority of the time. Contrary to our primary hypothesis, we did not find that HIV stigma was associated with time spent active. Nor did we find an association between perceived stigma and the intensity of activity. Whilst there was a statistically significant association between pain intensity and duration of activity ($p = 0.022$; higher pain associated with shorter duration of activity), and a statistically significant association between willingness to engage and intensity of activity ($p = 0.045$; greater score associated with greater intensity of activity), the interval estimates were very imprecise, and the limits of the interval estimates included very small effects. Consequently, we do not believe that these associations are meaningful.

The HIV stigma scale scores were similar to those recorded in populations of Indian, Swedish and Chinese PLWH [62–64]. Our data support the idea that HIV stigma remains prevalent in South Africa. Indeed, reports from the general South African population are that 66% of PLWH have experienced some form of HIV stigma at least once in the last 12 months [65] but our data suggest that HIV stigma may be more prevalent in PLWH with pain, which we have also found previously and may speak to the intersectionality of stigma related to both HIV and chronic pain [17, 66]. Indeed, in our previous study, we saw such intersectionality. We observed that a proportion of participants with both HIV and chronic pain had not told their family or friends about their pain for fear that any appearance of being 'sick' would reveal their HIV status and they would be potentially exposed to HIV stigma [15]. We hypothesised that PLWH and chronic pain may remain active to conceal their HIV status. More specifically, we hypothesised that participants would be active for long periods and activity would be of high intensity. This hypothesis was partly true: the data indicated that indeed, individuals were active for long periods, a median of about 7 h per day, but the intensity was very low. All individuals typically moved at or below a 'slow-walk' [61]. The uniform slow pace across participants may account for the lack of association between the intensity of activity and perceived stigma or any of the other covariates. That is, there was a floor effect.

The pattern of activity in our cohort appears to be different from other groups of PLWH. In a meta-analysis of 24 studies of activity in PLWH (measured both subjectively and objectively), participants were active on average for 99 min a day, which is much lower than the seven hours or 432 min that the participants in our study were active [67]. Two thirds of the participants in the meta-analysis were classified as moderately to highly physically active using the subjective measure of intensity, the International Physical Activity

Table 2 Duration of activity, full model

Parameter	Coefficient	95% CI low	95% CI high	t value	df	p value
HSS: stigma score	1.004	−2.632	4.640	0.550	71.900	0.584
BPI: pain intensity	−29.961	−55.415	−4.507	−2.346	72.023	0.022
Age (years)	0.356	−4.128	4.840	0.158	72.071	0.875
CPAQ-8: willingness to engage	−3.365	−12.143	5.413	−0.764	72.046	0.447
Self-rated wealth [B: money for food and clothes, but short on many other things]	61.625	−10.291	133.542	1.710	68.795	0.092
Self-rated wealth [C: have most important things, but few luxury goods]	−11.692	−181.173	157.788	−0.138	71.922	0.891

Pooled model from 5 imputed datasets

Table 3 Intensity of activity, full model

Parameter	Coefficient	95% CI low	95% CI high	t value	df	p value
HSS: stigma score	−0.001	−0.002	0.001	−0.724	72.070	0.471
BPI: pain intensity	0.000	−0.013	0.012	−0.062	72.059	0.951
Age (years)	0.001	−0.001	0.004	1.366	72.071	0.176
CPAQ-8: willingness to engage	0.004	0.000	0.008	2.037	72.069	0.045
Self-rated wealth [B: money for food and clothes, but short on many other things]	−0.003	−0.037	0.031	−0.202	71.571	0.841
Self-rated wealth [C: have most important things, but few luxury goods]	−0.023	−0.104	0.058	−0.573	72.059	0.568

Pooled model from 5 imputed datasets

Questionnaire (IPAQ). As our participants typically did not even reach the speed of a slow walk, it is unlikely that they would have classified as even moderately active.

The lack of variability in the intensity data and the lack of associations between activity and psychosocial factors means that we still do not know what the main drivers of activity in PLWH and chronic pain are. As the participants in our study were just starting ART, their viral suppression was low, and both low CD4 T-cell counts and high viral loads have associated with lower activity in PLWH [58, 68]. Whilst there is a dearth of objective activity data from South Africa, the same pattern of long duration but low intensity activity has been reported previously in South African children from rural areas [69], probably as a result of walking long distances to school [70], and so the activity pattern may be specific to the South African context and not just to living with HIV. The willingness to engage data suggest that participants were reluctant to move when in pain but as willingness to engage did not then associate with activity, like in another cohort of PLWH and chronic pain [26], something else may have been driving their activity. The pattern of long duration but low intensity activity, may well be reflective of the type of manual work the participants in our study were engaged in: of the employed (full time or part-time/piece work) the majority had manual jobs including cleaning work, waiting tables, childcare, and maintenance. Thus the low intensity activity may have been a means of pacing themselves, for example, for the 7–15 h half of the participants were active. Additionally, as fatigue is the most common symptom of HIV [71] the low intensity activity may have been a strategy to conserve energy [72]. Preliminary data suggest individuals with chronic pain may pace themselves too [73] and so there may be another intersectionality of HIV and chronic pain, a physiological intersectionality this time, whereby both conditions result in the need for pacing to manage energy and fatigue. Further exploration of the interplay between HIV, chronic pain, and managing fatigue is warranted.

Previously we have used employment status and education status as our measures of socioeconomic status. In our previous study we asked about participants' worries and the answers illustrated that people in chronic pain worried significantly more about money than about their health [15]. In this current cohort, 51% were employed full-time and 17% part-time, a higher proportion of employment than many of our other studies, yet 53% reported not having enough money even for basic things. A recent study from the US also reported that the majority of PLWH and chronic pain were living in poverty [66]. In a series of studies, economic insecurity was associated with having pain [74] and in a cohort of US PLWH and depression, having public or no health insurance was associated with having moderate or severe pain but social support and HIV stigma was not associated [75]. It appears, therefore, that being poor could be more algogenic than HIV stigma.

There were limitations to this study. The primary limitation was that we had to discard a significant amount of data (data for 70 participants, 46% of the original sample, Fig. 1). Forty-seven percent of those 70 participants' data had to be excluded because of a theft of accelerometers from the office of one of the investigators, while 34% of those 70 participants had to be excluded because of poor response characteristics of the accelerometers. However, when looking at the demographic and questionnaire data, there were no meaningful differences between the excluded and included participants (Supplements 1–7), so we do not believe that the reduced sample biased our results. Nor do we believe that the reduced sample size reduced our statistical power, resulting in us falsely retaining the null hypothesis; inspection of the univariate plots (Supplements 10, 11) showed no evidence of a relationship for any of the variables and the two activity outcomes we used. Some characteristics of the cohort may limit generalisability. For example, participants were enrolled in a clinical trial and were just starting ART. As such, they had low CD4 T-cell counts and high viral loads. Low CD4 T-cell counts and higher viral loads have been associated with lower physical activity [58, 68] and so

it is possible that cohorts of PLWH and chronic pain with better controlled HIV than we had here, may be more active.

Conclusions

In this analysis of 81 South Africans living with HIV and chronic pain we found that participants spent a median of about 7 h per day active, but that the intensity of activity was extremely low. We did not find any associations between perceived stigma or financial stress and activity. Whilst our motivation for exploring the relationship between perceived stigma and physical activity in PLWH and chronic pain was to inform the development of culturally-relevant pain management programmes, the lack of association between perceived stigma, perceived socioeconomic status, and any of the other covariates we assessed (pain intensity, willingness to engage and age), all of which have previously been reported to be associated with activity levels, indicates that in this population we are missing the primary drivers of sustained, but low intensity, activity. We suggest qualitative work to better understand beliefs and motivations around activity to inform culturally-relevant pain management programmes.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10461-022-03928-7.

Acknowledgements We are grateful to the patients of Ezintsha for taking part and the Ezintsha research staff for welcoming our team and their spirit of collaboration. We are also grateful to Flo Khumalo for research assistance and interpretation, and Andani Ratshinanga and Zipho Zwane for help with data collection.

Author Contributions Conceptualization: AW, TP, ME, RP; Methodology: AW, TP, ME, TC; Data analysis: PK; Writing—original draft preparation: AW, PK; Writing—review and editing: AW, PK, TP, ME, TC, FV, GA, MM, RP; Funding acquisition: AW, RP; Resources: AW, FV, GA, MM.

Funding Funding was received from a South African Medical Research Council Self-Initiated Research Grant and the Medical Faculty Research Endowment Fund of the University of the Witwatersrand, South Africa.

Data Availability All data, analysis scripts and analysis script outputs are available at Zenodo: https://doi.org/10.5281/zenodo.6631582.

Declarations

Competing Interests Antonia Wadley, Peter Kamerman, Tamar Pincus, Michael Evangeli, Tapiwa Chinaka, Michelle Moorhouse and Romy Parker declare that they have no competing interests. Venter's unit receives funding from the Bill and Melinda Gates Foundation, SA Medical Research Council, National Institutes for Health, AIDS Fonds, Unitaid, Foundation for Innovative New Diagnostics and the Children's Investment Fund Foundation, has recently received funding from USAID, and receives drug donations from ViiV Healthcare, Merck, J&J and Gilead Sciences for investigator-led clinical studies. The unit does investigator-led studies with Merck and ViiV providing financial support and is doing commercial drug studies for Merck. The unit performs evaluations of diagnostic devices for multiple biotech companies. Individually, he receives honoraria for educational talks and advisory board membership for Gilead, ViiV, Mylan, Merck, Adcock-Ingram, Aspen, Abbott, Roche, J&J, Sanofi and Virology Education.

Ethical Approval The study received ethical clearance from the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (Clearance No: M170560) and the study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

1. Parker R, Stein DJ, Jelsma J. Pain in people living with HIV/AIDS: a systematic review. J Int AIDS Soc. 2014;17:18719.
2. Sabin CA, Harding R, Bagkeris E, Nkhoma K, Post FA, Sachikonye M, et al. Pain in people living with HIV and its association with healthcare resource use, well being and functional status. AIDS. 2018;32(18):2697–706.
3. Yuan SB, Shi Y, Chen J, Zhou X, Li G, Gelman BB, et al. Gp120 in the pathogenesis of human immunodeficiency virus-associated pain. Ann Neurol. 2014;75(6):837–50.
4. Merlin JS, Westfall AO, Heath SL, Goodin BR, Stewart JC, Sorge RE, et al. Brief report: IL-1β levels are associated with chronic multisite pain in people living with HIV. J Acquir Immune Defic Syndr. 2017;75(4):e99-103.
5. Shi Y, Gelman BB, Lisinicchia JG, Tang SJ. Chronic-pain-associated astrocytic reaction in the spinal cord dorsal horn of human immunodeficiency virus-infected patients. J Neurosci. 2012;32(32):10833–40.
6. Madden VJ, Parker R, Goodin BR. Chronic pain in people with HIV: a common comorbidity and threat to quality of life. Pain Manag. 2020;10(4):253–60.
7. Treede RD, Rief W, Barke A, Aziz Q, Bennett MI, Benoliel R, et al. Chronic pain as a symptom or a disease: the IASP Classification of Chronic Pain for the International Classification of Diseases (ICD-11). Pain. 2019;160(1):19–27.
8. Scott W, Arkuter C, Kioskli K, Kemp H, McCracken LM, Rice ASC, et al. Psychosocial factors associated with persistent pain in people with HIV: a systematic review with meta-analysis. Pain. 2018;159(12):2461–76.
9. Frich LM, Borgbjerg FM. Pain and pain treatment in AIDS patients: a longitudinal study. J Pain Symptom Manag. 2000;19(5):339–47.
10. Merlin JS, Westfall AO, Chamot E, Overton ET, Willig JH, Ritchie C, et al. Pain is independently associated with impaired physical function in HIV-infected patients. Pain Med. 2013;14(12):1985–93.
11. Prioreschi A, Hodkinson B, Avidon I, Tikly M, McVeigh JA. The clinical utility of accelerometry in patients with rheumatoid arthritis. Rheumatology. 2013;52(9):1721–7.
12. Parker R, Bergman E, Mntambo A, Stubbs S, Wills M. Levels of physical activity in people with chronic pain. S Afr J Physiother. 2017;73(1):323.
13. Voss JG, Sukati NA, Seboni NM, Makoae LN, Moleko M, Human S, et al. Symptom burden of fatigue in men and women living with HIV/AIDS in Southern Africa. J Assoc Nurses AIDS Care. 2007;18(4):22–31.

14. Wahab KW, Salami AK. Pain as a symptom in patients living with HIV/AIDS seen at the outpatient clinic of a Nigerian Tertiary Hospital. J Int Assoc Physicians AIDS Care. 2011;10(1):35–9.
15. Wadley AL, Mitchell D, Kamerman PR. Resilience does not explain the dissociation between chronic pain and physical activity in South Africans living with HIV. PeerJ. 2016;4: e2464.
16. Parker R, Madden VJ, Devan D, Cameron S, Jackson K, Kamerman P, et al. Barriers to implementing clinical trials on nonpharmacological treatments in developing countries: lessons learnt from addressing pain in HIV. Pain Rep. 2019;4(6): e783.
17. Wadley AL, Pincus T, Evangeli M. A preliminary analysis of the association between perceived stigma and HIV-related pain in South Africans living with HIV. Afr J Prim Health Care Fam Med. 2019;11(1):1–5.
18. Venter WDF, Moorhouse M, Sokhela S, Fairlie L, Mashabane N, Masenya M, et al. Dolutegravir plus two different prodrugs of tenofovir to treat HIV. N Engl J Med. 2019;381(9):803–15.
19. Cleeland CS, Ryan KM. Pain assessment: global use of the Brief Pain Inventory. Ann Acad Med. 1994;23(2):129–38.
20. Mphahlele N, Mitchell D, Kamerman P. Validation of the Wisconsin Brief Pain Questionnaire in a multilingual South African population. J Pain Symptom Manag. 2008;36(4):396–412.
21. Wadley AL, Parker R, Mukhuba VA, Ratshinanga A, Zwane Z, Kamerman PR. South African men and women living with HIV have similar distributions of pain sites. Afr J Prim Health Care Fam Med. 2022;14(1):e1-9.
22. Bunn JY, Solomon SE, Miller C, Forehand R. Measurement of stigma in people with HIV: a reexamination of the HIV stigma scale. AIDS Educ Prev. 2007;19(3):198–208.
23. Berger BE, Ferrans CE, Lashley FR. Measuring stigma in people with HIV: psychometric assessment of the HIV stigma scale. Res Nurs Health. 2001;24(6):518–29.
24. Sherbourne CD, Stewart AL. The MOS social support survey. Soc Sci Med. 1991;32(6):705–14.
25. Fish RA, Hogan MJ, Morrison TG, Stewart I, McGuire BE. Willing and able: a closer look at pain Willingness and Activity Engagement on the Chronic Pain Acceptance Questionnaire (CPAQ-8). J Pain. 2013;14(3):233–45.
26. Moitra E, Stein MD, Busch AM, Pinkston MM, Abrantes AM, Baker JV, et al. Acceptance of chronic pain in depressed patients with HIV: correlations with activity, functioning, and emotional distress. AIDS Care. 2021;34(10):1338–46.
27. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med. 2001;16(9):606–13.
28. Bhana A, Rathod SD, Selohilwe O, Kathree T, Petersen I. The validity of the Patient Health Questionnaire for screening depression in chronic care patients in primary health care in South Africa. BMC Psychiatry. 2015;15:118.
29. Cholera R, Gaynes B, Pence B, Bassett J, Qangule N, Macphail C, et al. Validity of the patient health questionnaire-9 to screen for depression in a high-HIV burden primary healthcare clinic in Johannesburg, South Africa. J Affect Disord. 2014;167:160–6.
30. Derogatis LR, Lipman RS, Rickels K, Uhlenhuth EH, Covi L. The Hopkins Symptom Checklist (HSCL): a self-report symptom inventory. Behav Sci. 1974;19(1):1–15.
31. Pillay P, Wadley AL, Cherry CL, Karstaedt AS, Kamerman PR. Psychological factors associated with painful versus non-painful HIV-associated sensory neuropathy. AIDS Behav. 2018;22(5):1584–95.
32. R Core Team. R: a language and environment for statistical computing. Vienna: R Foundation for Statistical Computing; 2021. Available from: https://www.R-project.org/.
33. Robinson D, Hayes A, Couch S. Broom: convert statistical objects into tidy tibbles [Internet]. 2022. Available from: https://CRAN.R-project.org/package=broom.
34. Wickham H, François R, Henry L, Müller K. dplyr: a grammar of data manipulation [Internet]. 2022. Available from: https://CRAN.R-project.org/package=dplyr.
35. Gohel D. flextable: functions for tabular reporting [Internet]. 2022. Available from: https://CRAN.R-project.org/package=flextable.
36. Wickham H. forcats: tools for working with categorical variables (factors) [Internet]. 2021. Available from: https://CRAN.R-project.org/package=forcats.
37. Cameron A, van den Brand T. geomtextpath: curved text in "ggplot2" [Internet]. 2022. Available from: https://CRAN.R-project.org/package=geomtextpath.
38. Wickham H. ggplot2: elegant graphics for data analysis. New York: Springer-Verlag; 2016.
39. Sjoberg D, Whiting K, Curry M, Lavery J, Larmarange J. Reproducible summary tables with the gtsummary package. R J. 2021;13:570–80.
40. Firke S. janitor: simple tools for examining and cleaning dirty data [Internet]. 2021. Available from: https://CRAN.R-project.org/package=janitor.
41. Zhu H. kableExtra: construct complex table with "kable" and pipe syntax [Internet]. 2021. Available from: https://CRAN.R-project.org/package=kableExtra.
42. Grolemund G, Wickham H. Dates and times made easy with lubridate. J Stat Softw. 2011;40(3):1–25.
43. Wood SN. Generalized additive models: an introduction with R. 2nd ed. London: Chapman and Hall/CRC; 2017.
44. van Buuren S, Groothuis-Oudshoorn K. Mice: multivariate imputation by chained equations in R. J Stat Softw. 2011;45(3):1–67.
45. Lüdecke D, Ben-Shachar M, Patil I, Makowski D. Extracting computing and exploring the parameters of statistical models using R. J Open Source Softw. 2020;5(53):2445.
46. Lin Pedersen T. Patchwork: the composer of plots [Internet]. 2020. Available from: https://CRAN.R-project.org/package=patchwork.
47. Lüdecke D, Ben-Shachar M, Patil I, Waggoner P, Makowski D. Performance: an R package for assessment, comparison and testing of statistical models. J Open Source Softw. 2021;6(60):3139.
48. Henry L, Wickham H. purrr: functional programming tools [Internet]. 2020. Available from: https://CRAN.R-project.org/package=purrr.
49. Wickham H, Hester J, Bryan J. readr: read rectangular text data [Internet]. 2022. Available from: https://CRAN.R-project.org/package=readr.
50. Wickham H, Bryan J. readxl: read excel files [Internet]. 2019. Available from: https://CRAN.R-project.org/package=readxl.
51. Waring E, Quinn M, McNamara A, Arino de la Rubia E, Zhu H, Ellis S. skimr: compact and flexible summaries of data [Internet]. 2021. Available from: https://CRAN.R-project.org/package=skimr.
52. Wickham H. stringr: simple, consistent wrappers for common string operations [Internet]. 2019. Available from: https://CRAN.R-project.org/package=stringr.
53. Müller K, Wickham H. tibble: simple data frames [Internet]. 2021. Available from: https://CRAN.R-project.org/package=tibble.
54. Wickham H, Girlich M. tidyr: tidy messy data [Internet]. Available from: https://CRAN.R-project.org/package=tidyr.
55. Friendly M. vcdExtra: "vcd" extensions and additions [Internet]. 2022. Available from: https://CRAN.R-project.org/package=vcdExtra.
56. Textor J, van der Zander B, Gilthorpe M, Liśkiewicz M, Ellison G. Robust causal inference using directed acyclic graphs: the R package "dagitty." Int J Epidemiol. 2016;45:1887–94.
57. Rueda S, Mitra S, Chen S, Gogolishvili D, Globerman J, Chambers L, et al. Examining the associations between HIV-related

stigma and health outcomes in people living with HIV/AIDS: a series of meta-analyses. BMJ Open. 2016;6(7): e011453.
58. Vancampfort D, Mugisha J, Richards J, De Hert M, Probst M, Stubbs B. Physical activity correlates in people living with HIV/AIDS: a systematic review of 45 studies. Disabil Rehabil. 2018;40(14):1618–29.
59. Mishra R, Park C, York MK, Kunik ME, Wung SF, Naik AD, et al. Decrease in mobility during the COVID-19 pandemic and its association with increase in depression among older adults: a longitudinal remote mobility monitoring using a wearable sensor. Sensors. 2021;21(9):3090.
60. Lecrubier Y. Physical components of depression and psychomotor retardation. J Clin Psychiatry. 2006;67(Suppl 6):23–6.
61. Murtagh EM, Mair JL, Aguiar E, Tudor-Locke C, Murphy MH. Outdoor walking speeds of apparently healthy adults: a systematic review and meta-analysis. Sports Med. 2021;51(1):125–41.
62. Jeyaseelan L, Kumar S, Mohanraj R, Rebekah G, Rao D, Manhart LE. Assessing HIV/AIDS stigma in south India: validation and abridgement of the Berger HIV Stigma Scale. AIDS Behav. 2013;17(1):434–43.
63. Lindberg MH, Wettergren L, Wiklander M, Svedhem-Johansson V, Eriksson LE. Psychometric evaluation of the HIV stigma scale in a Swedish context. PLoS ONE. 2014;9(12): e114867.
64. Yu CH, Huang CY, Lee YT, Cheng SF. Development of an 18-item abbreviated Chinese version of Berger's HIV Stigma Scale. Int J Nurs Pract. 2019;25(2): e12708.
65. Peltzer K, Pengpid S. Prevalence and associated factors of enacted, internalized and anticipated stigma among people living with HIV in South Africa: results of the first national survey. HIV/AIDS (Auckland, NZ). 2019;11:275–85.
66. Hobson JM, Gilstrap SR, Owens MA, Gloston GF, Ho MD, Gathright JM, et al. Intersectional HIV and chronic pain stigma: implications for mood, sleep, and pain severity. J Int Assoc Provid AIDS Care. 2022. https://doi.org/10.1177/23259582221077940.
67. Vancampfort D, Mugisha J, De Hert M, Probst M, Firth J, Gorczynski P, et al. Global physical activity levels among people living with HIV: a systematic review and meta-analysis. Disabil Rehabil. 2018;40(4):388–97.
68. Bopp CM, Phillips KD, Fulk LJ, Dudgeon WD, Sowell R, Hand GA. Physical activity and immunity in HIV-infected individuals. AIDS Care. 2004;16(3):387–93.
69. Craig E, Bland R, Reilly J. Objectively measured physical activity levels of children and adolescents in rural South Africa: high volume of physical activity at low intensity. Appl Physiol Nutr Metab. 2013;38(1):81–4.
70. Statistics South Africa. National Households Travel Survey [Internet]. Pretoria, South Africa; 2020 [cited 2022 Jun 1]. Report No.: statistical release P0320. Available from: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/. https://www.statssa.gov.za/publications/P0320/P03202020.pdf.
71. Webel AR, Willig AL, Liu W, Sattar A, Boswell S, Crane HM, et al. Physical activity intensity is associated with symptom distress in the CNICS Cohort. AIDS Behav. 2019;23(3):627–35.
72. Brand R, Cheval B. Theories to explain exercise motivation and physical inactivity: ways of expanding our current theoretical perspective. Front Psychol. 2019;10:1147.
73. McMillan G, Dixon D. Self-regulatory processes, motivation to conserve resources and activity levels in people with chronic pain: a series of digital N-of-1 observational studies. Front Psychol. 2020;11: 516485.
74. Chou EY, Parmar BL, Galinsky AD. Economic insecurity increases physical pain. Psychol Sci. 2016;27(4):443–54.
75. Chapman Lambert C, Westfall A, Modi R, Amico RK, Golin C, Keruly J, et al. HIV-related stigma, depression, and social support are associated with health-related quality of life among patients newly entering HIV care. AIDS Care. 2020;32(6):681–8.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.