BJD
British Journal of Dermatology

What are the barriers to physical activity in patients with chronic plaque psoriasis?*

L. Auker,[1] L. Cordingley,[1] S.R. Pye,[2] C.E.M. Griffiths[1] and H.S. Young[1]

[1]Centre for Dermatology Research and [2]Division of Population Health, Health Services Research and Primary Care; The University of Manchester, Manchester Academic Health Science Centre, Manchester, UK

Linked Comment: Jarrett. Br J Dermatol 2020; **183**:988–989.

Summary

Background Psoriasis is associated with an increased risk of cardiovascular disease. Despite recommendation that exercise is important for cardiorespiratory fitness, patients with psoriasis avoid participation in physical activities for reasons that are, as yet, unclear.

Objectives This study investigated the relationship between psoriasis-specific experiences and self-reported patterns of exercise, hypothesizing that individuals with psoriasis are less likely to engage in physical activity for reasons that are related to their psoriasis.

Methods In total 404 patients with chronic plaque psoriasis were recruited. History, examination and physical activity were assessed for each participant.

Results Overall, 52·8% (n = 188) of patients with psoriasis aged 18–65 years and 66% (n = 37) of those aged > 65 years engaged in less than the recommended amount of physical activity for cardiorespiratory fitness. As the severity and psychosocial impact of psoriasis increased, the participation in exercise (of all intensities) decreased. There was a significant negative correlation between Psoriasis Area and Severity Index and total activity in women aged 18–65 years ($r = -0{\cdot}19$, 95% confidence interval −0·36 to 0; $P = 0{\cdot}04$) and a significant negative correlation between physical activity and Dermatology Life Quality Index (DLQI) in all participants ($r = -0{\cdot}11$, 95% confidence interval −0·21 to 0; $P = 0{\cdot}04$). Individual components of the DLQI identified barriers to physical activity including skin sensitivity and reluctance to participate in leisure activities.

Conclusions Psoriasis-specific factors – severity, skin sensitivity, clothing choice, participation in social/leisure activities, and treatments – contribute to exercise avoidance and may augment the increased risk of cardiovascular disease in patients with psoriasis.

Correspondence
Helen Young.
Email: helen.s.young@manchester.ac.uk

Accepted for publication
23 February 2020

Funding sources
This work was funded by a PhD studentship from the Psoriasis Association.

Conflicts of interest
C.E.M.G. is a National Institute for Health Research (NIHR) Senior Investigator and is funded in part by the NIHR Manchester Biomedical Research Centre. He has been a paid advisor for and/or is in receipt of research grants from AbbVie, Almirall, BMS, Galderma, Janssen, LEO Pharma, Lilly, MSD, Novartis, Pfizer, Sandoz, Regeneron, Walgreens Boots Alliance and UCB Pharma. H.S.Y. has served as a scientific consultant for or received research funding from Almirall, Aspire Pharma, Janssen-Cilag, Johnson & Johnson, LEO Pharma, Novartis and UCB Pharma.

*Plain language summary available online

DOI 10.1111/bjd.18979

What is already known about this topic?

- Psoriasis is associated with an increased prevalence of risk factors for cardiovascular disease.
- Despite recommendation that exercise is important for cardiorespiratory fitness, patients with moderate-to-severe psoriasis participate in very little physical exercise for reasons that are, as yet, unclear.

What does this study add?

- This study quantifies the significant lack of engagement with exercise in the population of people with psoriasis.
- Physical activity in those with psoriasis is significantly influenced by psoriasis severity, quality of life and a number of previously unrecognized psoriasis-specific barriers.

What is the translational message?

- Supporting patients with psoriasis to undertake regular physical activity could directly benefit weight management, cardiovascular disease and risk of metabolic syndrome, and increase wellbeing and psychosocial functioning.

Psoriasis is a common immune-mediated inflammatory skin disease affecting approximately 1–3% of the UK population.[1] It is associated with a number of comorbidities including cardiovascular disease (CVD)[2,3] and metabolic syndrome – obesity, hypertension and insulin resistance.[4] Psoriasis has a detrimental effect on social and leisure activities,[5,6] effectively presenting a barrier to health-promoting lifestyle choices such as engagement in physical activity.[7–10]

Physical exercise reduces CVD risk[11] by promoting a healthy body mass index, lowering blood pressure and reducing the levels of cholesterol and low-density lipoproteins in the blood. People who are physically active on a regular basis experience psychological benefits such as improved self-confidence and reduced levels of stress and anxiety.[12] According to the Committee on Exercise and Cardiac Rehabilitation of the American Heart Association (AHA), to promote and maintain cardiorespiratory health, all healthy adults aged 18–65 years should take part in moderate-intensity aerobic physical activity for a minimum of 30 min on 5 days each week, or vigorous-intensity aerobic physical activity for a minimum of 20 min on 3 days each week.[11] This is required to achieve a total energy expenditure of ≥ 500–1000 metabolic equivalent energy expenditure minutes per week (MET-mins/week).[13] MET-mins are equivalent to kilocalories for a person weighing 60 kg. Moderate- and vigorous-intensity exercise should be tailored to each individual's level of cardiorespiratory fitness for those over the age of 65 years.[14]

Despite widespread speculation that decreased physical activity in patients with psoriasis is consequent upon disease severity or is related to psychological barriers, objective evidence is limited and contradictory. Some investigators report that people with psoriasis avoid participating in physical activities more frequently than the general population,[9,15] although others describe similar levels of physical activity in those with and those without psoriasis.[16,17] A small study, which objectively measured activity using an accelerometer, reported that daily physical activity was greater in individuals with mild-to-moderate psoriasis than in healthy controls.[18] A Kuwaiti study described greater prevalence of avoidance of physical activity in patients with severe psoriasis.[19] Others report that patients with severe psoriasis [Psoriasis Area and Severity Index (PASI) ≥ 10] fear the (negative) reaction of other people to their skin disease and avoid using fitness centres and public swimming pools.[20]

However, how psoriasis impacts on physical activity and what the barriers to exercise are in patients with psoriasis remain unexplored. We hypothesized that individuals with psoriasis are less likely to engage in physical activity for reasons related to their psoriasis. We interrogated our hypothesis using objective, validated assessment tools to quantify the exercise undertaken and identify specific barriers to physical activity in individuals with psoriasis.

Patients and methods

Study population

Four hundred and four participants with chronic plaque psoriasis (aged ≥ 18 years) were recruited to this cross-sectional study from The Manchester Psoriasis Clinic (a regional secondary- and tertiary-care centre serving the North West of England) and primary-care centres with the same geographical footprint. The study was approved by the Salford local research ethics committee and was conducted in accordance with the Declaration of Helsinki principles. Written, informed consent was obtained from each participant. Participants were excluded from the study if they did not have psoriasis, if they were pregnant or breastfeeding, or if there were issues with capacity and consent.

Questionnaires

A detailed clinical history was taken from each participant and a psoriasis severity assessment including PASI (range 0–72) and Dermatology Life Quality Index (DLQI; range 0–30)[21–23] was documented. Detailed demographic and descriptive data of the study participants are outlined in Table 1.

The short-version International Physical Activity Questionnaire (IPAQ; range 0–18 900 MET-mins/week)[24,25] was used to quantify the type and quantity of exercise performed by each participant.

Patients with psoriasis believe they will be evaluated by others on the basis of their skin disease.[26,27] Patients frequently avoid situations where their psoriasis may be commented upon negatively by others[26,27] – a behaviour that could result in reduced physical activity. Although PASI is a widely used, validated measure of psoriasis severity it provides a snapshot assessment of a long-lasting disease process. In order to evaluate the impact of historical severity on exercise, the past history/interventions component of the Simplified Psoriasis Index (SPI-i) was used.[28] A higher SPI-i reflects a larger number of treatment interventions, longer disease

Table 1 Characteristics of the study participants

		Age (years)		Male			Female		
	Study group (n = 404)	18–65 (n = 336)	> 65 (n = 68)	Total (n = 189)	Age 18–65 years (n = 154)	Age > 65 years (n = 35)	Total (n = 215)	Age 18–65 years (n = 182)	Age > 65 years (n = 33)
Age (years)[a]	49 (38–61)	45 (36–54)	71 (67–77)	49 (39–63)	44 (36–52)	71 (67–77)	50 (37–61)	46 (35–55)	72 (68–76)
Age of psoriasis onset (years)[b]	23 (14–35)	20 (14–32)	40·5 (25–60)	25 (16–35)	22 (15–32)	40 (28–64)	21 (13–36)	20 (13–32)	45 (20–59)
Disease duration (years)[b]	20 (11–32)	19 (11–30)	30 (15–47)	19 (10–32)	18 (10–29)	32 (13–47)	22 (11–32)	21 (11–30)	26 (15–53)
Family history of psoriasis[b]	54·7	58·0	38	51·9	57·3	27	57·2	58·5	50
Body mass index (kg m^{-2})[a]	27·8 (24·5–31·6)	27·9 (24·6–31·9)	27 (24–31)	28 (25–31·4)	28 (25–31·4)	27·7 (25·3–31·5)	27·6 (24–31·7)	27·7 (24–32·3)	27 (23–30)
Smoking[c]	31·4	34·6	11	25·8	29·6	13	35·9	39·1	7
Hypertension[d]	29·1	24·3	53	29·1	23·4	54	29·1	25	52
Diabetes[c]	6·5	5·1	13	7·4	4·5	20	5·6	5·6	6
Atrial fibrillation[a]	5·2	3·6	13	6·9	3·9	20	3·8	3·3	6
Angina[a]	4	2·1	13	5·8	3·9	14	2·3	0·6	12
PASI[a]	2·5 (0·7–5·5)	2·7 (0·8–6)	1·8 (0·3–3·3)	3·4 (0·8–7)	3·7 (1·2–7·8)	1·6 (0·3–4·4)	2·1 (0·5–4·2)	2·2 (0·6–4·7)	1·9 (0·3–2·9)
DLQI[e]	4 (1–7)	4 (1–8)	2 (1–5)	3 (1–8)	4 (2–8)	1 (1–5)	4 (1–7)	4 (1–7)	4 (1–6)
Walking (MET-mins/week)[c]	792 (272–2079)	742 (297–2079)	1188 (264–2772)	990 (297–2772)	792 (297–2376)	1188 (264–2772)	693 (264–1732·5)	693 (264–1584)	982 (285–2005)
Moderate (MET-mins/week)[f]	0 (0–720)	0 (0–720)	0 (0–480)	160 (0–960)	180 (0–960)	140 (0–1590)	0 (0–480)	0 (0–480)	0 (0–120)
Vigorous (MET-mins/week)[g]	0 (0–960)	0 (0–1090)	0 (0–720)	100 (0–1560)	240 (0–1650)	0 (0–1200)	0 (0–920)	0 (0–960)	0 (0–360)
Total IPAQ (MET-mins/week)[h]	1767 (594–4068)	1823·3 (640–4103)	1414 (457–4068)	2158 (698–4526)	2158 (711–4541)	2396 (615–4565)	1529 (460–3155)	1584 (491–3467)	1065 (297–1900)
Low level of activity[i]	27·4	26·5	32	21·3	20·7	24	33	31·6	41
Moderate activity[i]	32·8	32·6	34	36·1	36·4	35	29·7	29·1	33
High level of activity[i]	39·8	40·9	34	42·6	42·9	41	37·3	39·2	26

The median (interquartile range) is presented for continuous variables and percentages are presented for categorical variables. DLQI, Dermatology Life Quality Index; MET-mins, metabolic equivalent energy expenditure minutes; PASI, Psoriasis Area and Severity Index. Missing values: [a]none, [b]1·5%, [c]11%, [d]22%, [e]5%, [f]9·6, [g]6·7%, [h]18·5, [i]8·6%.

duration, more hospital admissions and more episodes of erythroderma or pustular flares of psoriasis.[28]

The cumulative physical, psychosocial and economic burden of psoriasis may result in patients failing to reach their 'life potential'.[29] Patients may remain unwilling to engage in exercise, even during periods of disease quiescence, as a consequence of the lifetime impact of the disease. In order to investigate this, the SPI-i variable was modified by eliminating disease duration from the overall score.

Statistical analyses

All data were recorded on an Excel spreadsheet and were cleaned prior to statistical analyses. Missing observations were appropriately coded and the data were exported into IBM SPSS statistics for analysis (IBM, Armonk, NY, USA).

Descriptive statistics were used to summarize variables, with the median and interquartile range (IQR) given for non-normal continuous variables and percentages for categorical variables. The AHA guidelines were used as a standard measure of physical activity. Participants who achieved a total energy expenditure of ≥ 500 MET-mins/week as a consequence of moderate-intensity and/or vigorous-intensity aerobic physical activity were considered to have met the AHA guideline.[11,13] Chi-squared (χ^2) tests were used to examine differences in cardiovascular risk factors and comorbidities, and Health Survey for England[30] data in those who adhered to the AHA guideline and those who did not.

Spearman correlations were used to determine relationships between IPAQ and either PASI or components of SPI. To be conservative, Mann–Whitney U-tests were used to assess differences in modified SPI-i between those who did and did not adhere to the AHA guidelines for physical activity.

Spearman correlations were used to determine relationships between IPAQ and DLQI. Selected DLQI items investigated how itchy, sore or painful the skin had been (question 1); how embarrassed or self-conscious the respondents had felt (question 2); how psoriasis had influenced choice of clothes (question 4); how psoriasis had affected social or leisure activities (question 5); how psoriasis had affected their engagement with sports (question 6) and how difficult it had been to manage treatment of psoriasis (question 10). To be conservative, Mann–Whitney U-tests were used to compare the selected DLQI items with IPAQ. DLQI responses 'not at all' and 'a little' were coded as 0 ($DLQI_{low}$) and the responses 'a lot' and 'very much' were coded as 1 ($DLQI^{high}$).

In the general population, levels of physical activity are higher in men and decline with increasing age for both men and women. We hypothesized that gender and age may influence engagement with exercise and alter disease-specific barriers to physical activity in patients with psoriasis. In further analyses we compared the dichotomized DLQI responses ($DLQI^{high}$ or $DLQI_{low}$) with IPAQ in gender- and age-specific groupings; statistical significance was set at $P < 0{\cdot}001$ (two-sided; Bonferroni correction) to correct for multiple testing.

Multiple linear regression analysis was used to investigate the relationships between total IPAQ score as the dependent (continuous) variable and the following predictor or independent (continuous) variables: age, disease duration and selected DLQI questions (dichotomized as $DLQI^{high}$ or $DLQI_{low}$). Gender was included in the regression model as a binary independent variable; men were coded 1 and women as 2. All variables were selected a priori. The data met the assumptions of linearity without multicollinearity, and the variance of the residuals was constant and approximately normally distributed. Participants with missing values were excluded from the analyses.[31]

Results

The study group consisted of 189 men and 215 women, with a median age of 49 years (IQR 38–61), a median age of psoriasis onset of 23 years (IQR 14–35) and a median PASI of 2·5 (IQR 0·7–5·5). Overall, 54·7% (n = 221) had a family history of psoriasis (Table 1). In total 287 patients (71% overall) were recruited from primary care, and care was taken to sample from practices serving both deprived and affluent areas. Eighty-three patients (21%) had coexisting psoriatic arthritis, and 145 (36%) were on active treatment (defined as ultraviolet B, psoralen plus ultraviolet A, systemic therapies or biologics; data on topical treatments were not collected).

Engagement with the recommended amount of physical activity for cardiorespiratory health in patients with psoriasis

IPAQ responses identified 52·8% of participants (188 of 356) with psoriasis who failed to meet the recommended AHA guideline for physical activity (0–499 MET-mins/week). It was not possible to attribute adherence or nonadherence to the AHA guideline in 12% (n = 48) of the study group. There were significantly higher prevalences of hypertension (19·1%, n = 68; P = 0·003), diabetes (5·1%, n = 18; P = 0·004) and obesity (40·2%, n = 143; P = 0·045) in the group who were not following the AHA recommendation. Rates of smoking were comparable for participants adherent or nonadherent to the guideline.

When the study cohort was analysed by age, 50·3% (n = 151) of those aged 18–65 years (60%, n = 91 female and 40%, n = 60 male) engaged in less than the recommended amount of physical activity. In the cohort aged > 65 years, 66% of participants (n = 37; 54%, n = 20 female and 46%, n = 17 male) engaged in less than the recommended amount of physical activity.

In comparison with data from The Health Survey for England,[30] significantly more patients with psoriasis (60%, n = 111 female, $\chi^2 = 9{\cdot}09$, P = 0·003; 45%, n = 77 male, $\chi^2 = 6{\cdot}51$, P = 0·011) failed to exercise to the extent recommended by the AHA guidelines.

Table 2 Impact of selected Dermatology Life Quality Index (DLQI) questions on physical activity: whole cohort

	IPAQ (metabolic equivalent energy expenditure minutes per week)							
	Walking		Moderate		Vigorous		Overall	
DLQI questions	Median (IQR)	P-value	Median (IQR)	P-value	Median (IQR)	P-value	Median (IQR)	P-value
Q1. How itchy or sore?								
Low	792 (264–2079)	0·89	0 (0–720)	0·58	0 (0–1440)	0·001	1920 (594–4158)	0·24
High	792 (297–2426)		0 (0–480)		0 (0–480)		1664 (655–3312)	
Q2. How embarrassed?								
Low	957 (297–2079)	0·17	0 (0–720)	0·1	0 (0–1200)	0·04	1983 (660–4158)	0·01
High	693 (248–1386)		0 (0–480)		0 (0–480)		1188 (396–3189)	
Q4. Influenced clothing?								
Low	842 (264–2079)	0·59	0 (0–720)	0·22	0 (0–1158)	0·02	1898 (677–4158)	0·04
High	718 (297–1386)		0 (0–540)		0 (0–480)		1314 (480–3217)	
Q5. Influenced social activities?								
Low	792 (297–2079)	0·11	0 (0–800)	0·34	0 (0–1158)	0·01	1886 (693–4158)	0·01
High	644 (124–1386)		0 (0–480)		0 (0–0)		840 (149–2868)	
Q6. Difficult to do sport?								
Low	842 (297–2079)	0·09	0 (0–720)	0·21	0 (0–1440)	0·04	1935 (693–4158)	0·01
High	446 (107–1386)		0 (0–300)		0 (0–0)		594 (66–1737)	
Q10. Treatment problematic?								
Low	924 (330–2079)	0·04	0 (0–720)	0·66	0 (0–1200)	0·29	1905 (660–4158)	0·11
High	594 (116–1386)		0 (0–1080)		0 (0–720)		1314 (452–3066)	

IQR, interquartile range. DLQI responses 'not at all' and 'a little' were coded as low and the responses 'a lot' and 'very much' were coded as high. P-values are from the Mann–Whitney U-test. P-values ≤ 0·05 are statistically significant.

The relationship between physical activity and severity of psoriasis

Spearman correlation analysis revealed a small but significant negative correlation between PASI and total IPAQ scores in women aged 18–65 years [r = −0·19, 95% confidence interval (CI) −0·36 to 0, P = 0·04], indicating that as PASI increased, participation in exercise (of all intensities) decreased. Analysis of other gender- and age-specific groupings revealed no relationship between PASI and physical activity.

Spearman correlation revealed a small but significant negative correlation between SPI-i and vigorous-intensity physical activity scores (r = −0·11, 95% CI −0·22 to 0, P = 0·05) for the study group. As psoriasis severity increased, the amount of vigorous-intensity physical activity decreased. This relationship was stronger in women aged > 65 years, and a significant negative correlation was found between their intervention scores and vigorous-intensity physical activity scores (r = −0·40, 95% CI −0·69 to 0, P = 0·05). Analysis of other gender- and age-specific groupings revealed no significant associations between intervention and physical activity.

We observed that patients with psoriasis who did not meet the AHA guideline had significantly higher (modified) SPI-i (P = 0·03) in comparison with those with 'healthy' levels of physical activity. However, there was no significant correlation between (modified) SPI-i and physical activity.

The impact of exercise on quality of life and psoriasis-specific barriers to physical activity

We observed a small but statistically significant negative correlation between physical activity and total DLQI (r = −0·11, 95% CI −0·21 to 0, P = 0·04), suggesting that as DLQI increases, engagement with physical activity decreases.

To identify specific barriers to exercise we interrogated six of the 10 DLQI questions, which we believed had the potential to impact upon engagement with physical activity. Embarrassment/self-consciousness (question 2; $DLQI_{low}$ 1983 MET-mins/week, $DLQI^{high}$ 1188 MET-mins/week, P = 0·01), clothing choice (question 4; $DLQI_{low}$ 1898 MET-mins/week, $DLQI^{high}$ 1314 MET-mins/week, P = 0·04), impact on social/leisure activities (question 5; $DLQI_{low}$ 1886 MET-mins/week, $DLQI^{high}$ 840 MET-mins/week, P = 0·01) and skin disease that made playing sport difficult (question 6; $DLQI_{low}$ 1935 MET-mins/week, $DLQI^{high}$ 594 MET-mins/week, P = 0·01) significantly reduced levels of overall physical activity, particularly through a significant reduction in vigorous-intensity activity (Table 2). In addition, skin sensitivity (question 1; P = 0·001) significantly reduced levels of vigorous-intensity physical activity, and problems with treatment (question 10; P = 0·04) significantly reduced levels of walking-intensity physical activity (Table 2).

In further analyses, DLQI responses were compared with IPAQ in gender- and age-specific groupings, and statistical significance was corrected to account for multiple testing. Given

our relatively small sample size, none of the subgroup analyses reached statistical significance. However, those data with $P < 0{\cdot}1$ are described and may be suggestive of trends (Tables S1–S4; see Supporting Information). Participants in all gender- and age-specific groups reported that skin sensitivity (question 1) reduced their engagement with vigorous-intensity activity (Tables S1–S4). Women with psoriasis and women aged 18–65 years who indicated that their skin disease made playing sport difficult (question 6) had reduced total IPAQ scores (all women $P = 0{\cdot}002$, women aged 18–65 years $P = 0{\cdot}002$; difference not significant). They also engaged in less vigorous-intensity activity (all women $P = 0{\cdot}03$, women aged 18–65 years $P = 0{\cdot}02$; not significant), moderate-intensity activity (all women $P = 0{\cdot}07$, women aged 18–65 years $P = 0{\cdot}06$; not significant) and walking-intensity activity (all women $P = 0{\cdot}08$, women aged 18–65 years $P = 0{\cdot}09$; not significant) than those who reported 'not at all' or 'a little' to question 6 (Tables S1 and S2).

In contrast, difficulty with sport made no impact on engagement with activity for male patients with psoriasis and men aged 18–65 years (Tables S3 and S4; $P > 0{\cdot}1$). In addition, embarrassment/self-consciousness (question 2) reduced total IPAQ scores and engagement with vigorous-intensity activity for male patients (total IPAQ $P = 0{\cdot}01$, vigorous activity $P = 0{\cdot}07$; difference not significant; Table S3) and men aged 18–65 years (total IPAQ $P = 0{\cdot}03$, vigorous activity $P = 0{\cdot}1$, not significant; Table S4). Participation in social/leisure activities (question 5) reduced total IPAQ scores and engagement with vigorous-intensity activity and walking-intensity activity for male patients (total IPAQ $P = 0{\cdot}01$, vigorous activity $P = 0{\cdot}02$, walking $P = 0{\cdot}07$; not significant; Table S3) and men aged 18–65 years (total IPAQ $P = 0{\cdot}02$, vigorous activity $P = 0{\cdot}04$, walking $P = 0{\cdot}1$; not significant; Table S4). For male patients with psoriasis, problems with treatment (question 10) reduced the total IPAQ score ($DLQI_{low}$ 2465 MET-mins/week, $DLQI^{high}$ 1314 MET-mins/week, $P = 0{\cdot}07$; not significant; Table S3) and engagement with walking-intensity activity ($DLQI_{low}$ 1188 MET-mins/week, $DLQI^{high}$ 594 MET-mins/week, $P = 0{\cdot}08$; not significant; Table S3).

The association between gender and disengagement with physical activity in patients with psoriasis

Having described a significant relationship between patient responses to selected DLQI questions and reduced physical activity, in addition to demonstrating that female patients with psoriasis have significant difficulty engaging with exercise, we investigated whether the association between exercise and gender was independent of DLQI by performing a multiple regression analysis.

The model (Table 3) explained 7% of the variance in total IPAQ scores, which was significant ($R^2 = 0{\cdot}07$, $P = 0{\cdot}03$). Gender was a significant predictor of physical activity, after adjustment for age, disease duration and DLQI. On average women expended 1359 (95% CI −2170 to −548, $P = 0{\cdot}001$) less MET-min/week than men (Table 3). These data suggest that women with psoriasis disengage from exercising to a greater extent than men. Age was also a significant predictor of physical activity, after adjustment for gender, disease duration and DLQI. On average individuals expended 28·9 (95% CI −58·0 to 0·09, $P = 0{\cdot}05$) less MET-min/week for each year of life (Table 3). However, the R^2-values for the model were low, indicating that there may be additional external factors impacting on levels of physical activity in patients with psoriasis (Table 3). The characteristics of the cases omitted due to missing data were similar to those of the whole group (Table S5; see Supporting Information).

Table 3 The relationship between total International Physical Activity Questionnaire (IPAQ) score and predictor variables including chronological age, gender, disease duration and Dermatology Life Quality Index (DLQI) questions 1, 2, 4, 5, 6 and 10: results from multiple linear regression (n = 318)

Predictor variables	Unstandardized B-coefficient (95% CI)	P-value
Age (years)	−28·94 (−57·97, 0·09)	0·05
Sex; male = 1, female = 2	−1359 (−2170, −548·4)	0·001
Disease duration (years)	12·05 (−16·90, 41·00)	0·41
DLQI question 1: how itchy or sore?	38·63 (−931·8, 1009)	0·94
DLQI question 2: how embarrassed or self-conscious?	−427·5 (−1697, 842·1)	0·51
DLQI question 4: influenced clothing choice?	93·96 (−1115, 1302)	0·89
DLQI question 5: influenced social or leisure activities?	−1054 (−2848, 740·0)	0·25
DLQI question 6: difficult to do sport?	176·4 (−1781, 2134)	0·86
DLQI question 10: has treatment been problematic?	−411·0 (−1758, 936·4)	0·55

CI, confidence interval. The R^2-value for this model was 0·07, $P = 0{\cdot}03$. P-values ≤ 0·05 are statistically significant. Responses to the DLQI questions of 'not at all' and 'a little' were recorded as $DLQI_{low}$, and 'a lot' and 'very much' as $DLQI^{high}$. The B-coefficient for each DLQI question represents the change in IPAQ score for an increase from $DLQI_{low}$ to $DLQI^{high}$. Missing values (21%) were excluded.

Discussion

We report low levels of physical activity in patients with psoriasis and identify significant barriers to exercise, which are both gender and psoriasis specific. We describe a significant relationship between severity of psoriasis – as measured by PASI, historical severity and treatment intervention, and DLQI

– and the likelihood of limiting physical activity. Individual items of the DLQI have utility in identifying psoriasis-specific barriers to physical activity.

Although others have suggested that patients with psoriasis have decreased levels of physical activity in comparison with healthy controls,[9] the level of inactivity revealed in our study was unexpected and unprecedented. Around 50% of our cohort aged 18–65 years and 66% of patients aged > 65 years engaged in less than the recommended amount of physical activity for cardiorespiratory fitness. Our study utilized the IPAQ, which can overestimate physical activity compared with measurement with an accelerometer,[32,33] thus their levels of physical activity may have been even lower.

Significantly more women with psoriasis (60%) than men (45%) did not exercise as recommended for cardiovascular health. Perhaps the burden of psoriasis is more significant for women,[34] which might influence the likelihood of exercising, although the psychosocial impact of psoriasis is reportedly similar for both groups.[35] In comparison, The Health Survey for England identified that 33% of men and 45% of women, aged ≥ 16 years, failed to meet the guideline requirement for aerobic activity.[30] In the general population, levels of physical activity are consistently higher in men, leading to speculation that men enjoy physical activity whereas women exercise with the goal of improving either their health or their physical appearance.[36,37] The World Health Organization reports that women may have limited time available for exercise due to homemaking and caregiving roles within the family.[38] The Health Survey for England also demonstrated that adherence to the recommended amount of physical activity declines with age. Men aged 16–24 years are most likely to adhere to the guideline, whereas the proportion of women meeting the guideline rises to a peak at age 35–44 years before decreasing.[30]

These low levels of physical activity represent an aspect of patient management that should be targeted for intervention given the high prevalence of CVD in patients with psoriasis. However, this cannot be achieved unless the barriers to exercise engagement and the reasons for these lifestyle choices are understood. Several groups have speculated that reluctance to engage in exercise may stem from comorbid disease, such as psoriatic arthritis, which may directly affect physical ability.[39] The visible symptoms of psoriasis, driving fear of rejection, feelings of stigmatization and low mood, may limit exercise.[6,40]

We report, for the first time, quantitative, objective evidence that the severity of psoriasis, as measured by PASI, is significantly negatively correlated with physical activity. We also demonstrate that those with a greater impact of psoriasis on their quality of life, measured by DLQI, have lower levels of physical exercise than those who are less affected by their psoriasis. However, assessment of psoriasis severity is complex; PASI reflects current severity and is not necessarily representative of the historical severity of a chronic disease process. Participants in our study had relatively low PASI, although we demonstrate that historical severity as measured by SPI-i was also significantly negatively correlated with physical activity. Our observed loss of correlation between unmodified SPI-i and physical activity suggests that disease duration may be a key factor in engagement with exercise, possibly due to the chronicity of the disease influencing the opportunity to develop health-promoting behaviours. Clearly, disease severity is an important psoriasis-specific barrier, which highly influences engagement with exercise.

Selected components of the DLQI reflecting the challenges of living with psoriasis, including skin sensitivity, clothing choice, participation in social and leisure activities, and treatments, significantly influenced exercise engagement in our patient group. Our data suggest that DLQI has significant utility in revealing the likely extent of exercise undertaken by patients with psoriasis. Greater notice of the responses to individual questions, rather than the composite DLQI score, may afford clinicians key insight into the challenges faced by patients in increasing their level of physical activity.

There are some limitations in this study. Firstly, the short-version IPAQ, used to reduce the questionnaire burden on participants, does not account for occupational activity, although tests of reliability and validity suggest that this is unlikely to have had a significant impact on the data collected.[24] It was beyond the scope of our study to investigate the relationship between occupational activity or frequency of homemaker and caregiver roles, which might have influenced these data. Secondly, the present study was centred in North West England, an area of the UK with high levels of socioeconomic deprivation, which might influence exercise adherence. In order to mitigate this, participants in the study were recruited from across the North West region and care was taken to sample from primary-care practices serving both affluent and deprived areas. Thirdly, the study population had a 21% prevalence of psoriatic arthritis. Mood was not formally assessed. It was beyond the scope of this study to interrogate the influence of arthritis and mood on exercise adherence, which could be potential confounders in this study.

Fourthly, we did not document whether participants marked 'not relevant' on the sports or social/leisure questions of the DLQI. Interrogation of such responses might have identified further individuals who were not exercising due to their psoriasis. Fifthly, we did not measure nonpsoriasis-related reasons for low levels of physical activity, and it is possible that these may be similar for both patients with psoriasis and the general population. However, we did make comparison with levels of physical activity reported in The Health Survey for England and report that a significantly greater proportion of patients with psoriasis failed to exercise to a health-promoting extent than the general population. Sixthly, participants with missing values were excluded from the analyses.[31] However, the characteristics of the cases omitted were similar to those of the whole group so this was unlikely to have biased the results (Table S5; see Supporting Information). Finally, it is possible that, even in periods of treatment-induced remission, the long-term impact of the disease together with the degree of disease activity during

early life may be a key determinant of exercise engagement. Recognizing this as a potential confounder in our study and having observed relatively low PASI for our study participants, we interrogated SPI-i, as a surrogate marker of historical psoriasis severity, as patients could have had significant periods of well-controlled psoriasis as a consequence of having numerous therapeutic interventions.

Some individuals consider exercise a recreational pursuit as opposed to a mechanism by which overall health and wellbeing can be improved.[41] However, whatever the motivation, physical activity is beneficial in the prevention and management of CVD and its associated risk factors.[11] This is important as patients with psoriasis have an increased risk of CVD.[42] Individuals who are physically active, on a regular basis, may also experience psychological benefits such as improvement in self-confidence, lower levels of stress and reduced anxiety levels.[12] Previous work in our group has shown that clinicians find facilitating lifestyle behaviour change challenging in patients with psoriasis.[43]

In conclusion, patients with psoriasis have levels of physical activity below that recommended for cardiovascular health. Health-promoting levels of exercise, in those with psoriasis, is significantly limited by disease severity, quality of life and a number of previously unrecognized psoriasis-specific barriers. However, regular moderate and vigorous physical activity should be actively promoted for all people with psoriasis.

References

1 Parisi R, Symmons DPM, Griffiths CEM *et al.* Global epidemiology of psoriasis: a systematic review of incidence and prevalence. *J Invest Dermatol* 2013; **133**:377–85.

2 Gisondi P, Girolomoni G. Cardiometabolic comorbidities and the approach to patients with psoriasis. *Actas Dermosifiliogr* 2009; **2**:14–21.

3 Gottlieb AB, Dann F. Comorbidities in patients with psoriasis. *Am J Med* 2009; **122**:1150.

4 Bruce KD, Hanson MA. The developmental origins, mechanisms, and implications of metabolic syndrome. *J Nutr* 2010; **140**:648–52.

5 Kimball AB, Gieler U, Linder D *et al.* Psoriasis: is the impairment to a patient's life cumulative? *J Eur Acad Dermatol Venereol* 2010; **24**:989–1004.

6 Bundy C, Cordingley L, Griffiths CEM. Psoriasis and psychodermatology. In: *Practical Psychodermatology* (Bewley A, Taylor RE, Reichenberg JS, Magid M, eds). Oxford: Wiley Blackwell, 2014; 90–7.

7 Devrimci-Ozguven H, Kundakci N, Kumbasar H *et al.* The depression, anxiety, life satisfaction and affective expression levels in psoriasis patients. *J Eur Acad Dermatol Venereol* 2000; **14**:267–71.

8 Naldi L, Conti A, Cazzaniga S *et al.* Diet and physical exercise in psoriasis: a randomized controlled trial. *Br J Dermatol* 2014; **170**:634–42.

9 Torres T, Alexandre JM, Mendonça D *et al.* Levels of physical activity in patients with severe psoriasis: a cross-sectional questionnaire study. *Am J Clin Dermatol* 2014; **15**:129–35.

10 Wilson PB, Bohjanen KA, Ingraham SJ *et al.* Psoriasis and physical activity: a review. *J Eur Acad Dermatol Venereol* 2012; **26**:1345–53.

11 Haskell WL, Lee IM, Pate RR *et al.* Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation* 2007; **116**:1081.

12 Myers J. Exercise and cardiovascular health. *Circulation* 2003; **107**: e2–5.

13 Garber CE, Blissmer B, Deschenes MR *et al.* American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Med Sci Sports Exerc* 2011; **43**:1334–59.

14 Nelson ME, Rejeski WJ, Blair SN *et al.* Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. *Circulation* 2007; **116**:1094.

15 Naldi L, Chatenoud L, Linder D *et al.* Cigarette smoking, body mass index, and stressful life events as risk factors for psoriasis: results from an Italian case–control study. *J Invest Dermatol* 2005; **125**:61–7.

16 Qureshi AA, Choi HK, Setty AR *et al.* Psoriasis and the risk of diabetes and hypertension: a prospective study of US female nurses. *Arch Dermatol* 2009; **145**:379–82.

17 Mallbris L, Granath F, Hamsten A *et al.* Psoriasis is associated with lipid abnormalities at the onset of skin disease. *J Am Acad Dermatol* 2006; **54**:614–21.

18 Demirel R, Genc A, Ucok K *et al.* Do patients with mild to moderate psoriasis really have a sedentary lifestyle? *Int J Dermatol* 2013; **52**:1129–34.

19 Al-Mazeedi K, El-Shazly M, Al-Ajmi HS. Impact of psoriasis on quality of life in Kuwait. *Int J Dermatol* 2006; **45**:418–24.

20 Khoury LR, Danielsen PL, Skiveren J. Body image altered by psoriasis. A study based on individual interviews and a model for body image. *J Dermatolog Treat* 2014; **25**:2–7.

21 Basra MKA, Fenech R, Gatt RM *et al.* The Dermatology Life Quality Index 1994–2007: a comprehensive review of validation data and clinical results. *Br J Dermatol* 2008; **159**:997–1035.

22 Finlay AY, Khan GK. Dermatology Life Quality Index (DLQI) – a simple practical measure for routine clinical use. *Clin Exp Dermatol* 1994; **19**:210–16.

23 Finlay AY. Current severe psoriasis and the rule of tens. *Br J Dermatol* 2005; **152**:861–7.

24 Craig CL, Marshall AL, Sjostrom M *et al.* International Physical Activity Questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc* 2003; **35**:1381–95.

25 International Physical Activity Questionnaire. Guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ) – short and long forms. Available at: http://www.dphu.org/uploads/attachements/books/books_314_0.pdf (last accessed 5 March 2020).

26 Fortune DG, Main CJ, O'Sullivan TM *et al.* Assessing illness-related stress in psoriasis: the psychometric properties of the Psoriasis Life Stress Inventory. *J Psychosom Res* 1997; **42**:467–75.

27 Fortune DG, Richards HL, Corrin A *et al.* Attentional bias for psoriasis-specific and psychosocial threat in patients with psoriasis. *J Behav Med* 2003; **26**:211–24.

28 Chularojanamontri L, Griffiths CEM, Chalmers RJ. The Simplified Psoriasis Index (SPI): a practical tool for assessing psoriasis. *J Invest Dermatol* 2013; **133**:1956–62.

29 Warren RB, Kleyn CE, Gulliver WP. Cumulative life course impairment in psoriasis: patient perception of disease-related impairment throughout the life course. *Br J Dermatol* 2011; **164** (Suppl. 1):1–14.

30 National Health Service. Health Survey for England, 2012. Available at: https://digital.nhs.uk/data-and-information/publications/statistical/health-survey-for-england/health-survey-for-england-2012 (last accessed 5 March 2020).

31 Hollestein LM, Carpenter JR. Missing data in clinical research: an integrated approach. *Br J Dermatol* 2017; **177**:1463–5.
32 Lee PH, Macfarlane DJ, Lam TH, Stewart SM. Validity of the International Physical Activity Questionnaire Short Form (IPAQ-SF): a systematic review. *Int J Behav Nutr Phys Act* 2011; **8**:115.
33 Dyrstad SM, Hansen BH, Holme IM *et al.* Comparison of self-reported versus accelerometer-measured physical activity. *Med Sci Sports Exerc* 2014; **46**:99–106.
34 Sampogna F, Chren MM, Melchi CF *et al.* Age, gender, quality of life and psychological distress in patients hospitalized with psoriasis. *Br J Dermatol* 2006; **154**:325–31.
35 Gupta MA, Gupta AK. Age and gender differences in the impact of psoriasis on quality of life. *Int J Dermatol* 1995; **34**:700–3.
36 Troiano RP, Berrigan D, Dodd KW *et al.* Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc* 2008; **40**:181–8.
37 Azevedo MR, Araújo CLP, Reichert FF *et al.* Gender differences in leisure-time physical activity. *Int J Public Health* 2007; **52**:8–15.
38 Verhoef MJ, Love EJ, Rose MS. Women's social roles and their exercise participation. *Women Health* 1992; **19**:15–29.
39 Balato N, Megna M, Palmisano F *et al.* Psoriasis and sport: a new ally? *J Eur Acad Dermatol Venereol* 2014; **30**:12607.
40 Ramsay B, O'Reagan M. A survey of the social and psychological effects of psoriasis. *Br J Dermatol* 1988; **118**:195–201.
41 Chao D, Foy CG, Farmer D. Exercise adherence among older adults: challenges and strategies. *Control Clin Trials* 2000; **21**:212s–217s.
42 Samarasekera EJ, Neilson JM, Warren RB *et al.* Incidence of cardiovascular disease in individuals with psoriasis: a systematic review and meta-analysis. *J Invest Dermatol* 2013; **133**:2340–6.
43 Nelson PA, Keyworth C, Chisholm A *et al.* 'In someone's clinic but not in *mine*' – clinicians' views of supporting lifestyle behaviour change in patients with psoriasis: a qualitative interview study. *Br J Dermatol* 2014; **171**:1116–22.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Table S1 Impact of selected Dermatology Life Quality Index questions on physical activity: women only.

Table S2 Impact of selected Dermatology Life Quality Index questions on physical activity: women aged 18–65 years only.

Table S3 Impact of selected Dermatology Life Quality Index questions on physical activity: men only.

Table S4 Impact of selected Dermatology Life Quality Index questions on physical activity: men aged 18–65 years only.

Table S5 The demographic data of participants included in the multiple linear regression analysis (n = 318) were similar to those of the whole study group (n = 404).