The contribution of local authority leisure provision to physical activity in the UK: evidence from a large population-based cohort

Abstract

***Background**:* Physical activity (PA) levels vary across specific population groups, contributing to health inequalities. Little is known about how local authority leisure centres contribute to population PA, and whether this differs by age, sex or socioeconomic group.

Methods: We calculated weekly leisure centre-based moderate/vigorous PA for 20,904 registered adult users of local authority leisure facilities in Northumberland, U.K., between July 2018-June 2019, using administrative data. We categorised activity levels (<30 minutes/week, 30-149 minutes/week and 150+ minutes/week) and used ordinal regression to examine predictors for activity category achieved.

Results: Registered users were mainly female (58.7%), younger (23.9% aged 18-29 years versus 10.1% aged 70+ years) and from the two most affluent socio-economic quintiles (53.7%). Median weekly moderate/vigorous leisure centre-based activity was 55 (IQR 30-99) minutes/week. Being female (OR: 2.09, 95% CI: 1.95-2.35), older (OR: 1.14, 95% CI: 1.11-1.16), and using a large facility (OR: 1.21, 95% CI: 1.03-1.42) were positive predictors of leisure centre-based PA.

Conclusion: Older adults and females were more likely to be active and achieve recommended PA levels through centre usage. Widespread use of this novel measure of leisure centre-based activity would improve understanding of how local authority leisure centres can address physical inactivity and associated inequalities.

1 Background

Physical inactivity causes 9% of premature death globally.[1] Achieving recommended levels of physical activity (PA) is associated with risk reductions of 35% in cardiovascular mortality and 33% in all-cause mortality,[2] 30% in diabetes,[3] 20-40% in breast cancer[4] and 20-30% in colon cancer.[5] Additionally, regular PA promotes social interactions and social equity,[6 7] and is positively associated with mental health.[8] Therefore, the World Health Organisation identifies increasing population levels of PA as a public health priority.[9]

Progress to improve PA has been slow; globally 1 in 4 adults do not currently meet the recommended ≥150 minutes of weekly moderate or 75 minutes of vigorous PA, or a combination of both.[10] United Kingdom (UK) PA levels for adults are broadly similar to other European countries such as Sweden and Spain,[11] however, in 2019 36.7% of adults aged over 18 years in England failed to meet World Health Organisation recommendations for PA,[12] putting them at a significantly greater risk of cardiovascular disease, and premature mortality.[13] By 2030, it is estimated that the UK population will be 35% less active if current trends continue.[14] PA levels are strongly influenced by demographics such as age and sex.[13] In England, 63.3% of the population were estimated to be sufficiently active in 2018-19, with men more likely to report being active than women (65% and 61% respectively). Activity levels decrease with age (70% of 16-34 year olds report being physically active compared to 40% of those aged 75 and over).[15] Additionally, those people who are in managerial, administrative and professionals occupations are more likely to be active compared to those who are long-term unemployed or have never worked (72% and 54% respectively).[15] Occupation is a common indicator of socioeconomic status; therefore it is likely that these data indicate that less affluent people are less active.

In more economically developed countries, like the UK, leisure time PA (LTPA) is an important sub-domain of PA, which is associated with significant protection against heart disease,[16] and a reduction in all-cause mortality.[17,18] For these countries, a greater understanding of LTPA at a local/regional level is important to help plan potential solutions to increase population levels of PA and address inequalities in PA. One potential source of LTPA data is that collected routinely by fitness facilities about service usage, but there are a lack of studies examining these data to investigate whether demographic factors affect attendance, and the contribution of fitness facility usage to population PA levels.

In 2018 in the UK, the fitness industry consisted of 7,239 facilities, of which 4,510 (62.3%) were privately owned and 2,729 (37.7%) are publically owned.[19] In this study, privately owned refers to privately owned facilities with a gym and/or fitness class studio. Publically owned refers to any leisure centres/facilities owned by local authorities with a gym and/or fitness class studio. Both private and publically owned sites may also offer additional facilities such as a swimming pool and/or sports facilities such as indoor sports halls or tennis courts. All facilities offer monthly paid membership options, but local authority owned sites more likely to offer pay-as-you-go options, where participants pay for an activity at the point of booking. Typically, they also offer reduced cost options to those for whom cost may be a barrier to access (e.g. those living in areas of deprivation, those with disabilities etc.). Studies have demonstrated that the provision of free local authority owned leisure centre usage is associated with increased usage both for the whole population,[20] and those living in areas of deprivation,[20 21] but have not attempted to objectively measure the amount of LTPA undertaken. This study aimed to estimate the contribution of local authority owned leisure centre usage to population levels of LTPA by using a large anonymised routine service-use dataset.

2 Methods

This study examined the contribution of local authority leisure centre provision to PA in a large population-based cohort in Northumberland, UK. Edinburgh Napier University School of Health and Social Care Integrity Committee gave ethical approval for the secondary analysis of these anonymised data (REF: SHSC19023).

2.1 Context

Northumberland is the largest unitary authority by area (5,013km^2) and the least densely populated (62 people per km^2) county in England. The population is 319,030 and is 98.4% white.[22] Compared to the rest of England, health in the county is mixed. Life expectancy for women is lower than the national average. Male life expectancy varies by 10.2 years and female by 8.8 years between the most and least deprived areas of the county.[23] The 2019 Sport England Active Lives Survey indicates that 67.7% (95% CI 62.3%-72.6%) of Northumberland adults achieve the UK physical activity guidelines compared to 63.3% nationally, while 20.9% (95% CI 16.9%-25.6%) are inactive (doing less than 30 minutes of PA per week).[15]

2.2 Study setting and dataset

We performed a retrospective analysis of leisure centre usage by extracting anonymised data from Active Northumberland, a charitable leisure trust that has operated local authority leisure facilities and delivered associated services to all residents on behalf of Northumberland local authority since 2013. The trust managed 17 leisure sites across Northumberland, nine large leisure centres with swimming pools and eight smaller sites; four school shared used sites (one with a pool) one leisure centre without a pool and three community sites. No leading UK private fitness industry provider with multiple facilities (e.g.

Pure Gym, The Gym Group, Anytime fitness) operated in the county, although we identified 28 independent fitness facilities (one site businesses) and 3 hotel-based gyms via internet searching.

Leisure centre usage data such as the date, type and length of activity were tracked via the front desk system (FDS), Gladstone MRM (Gladstone Ltd, Oxford, U.K.), which provided objective, detailed user information about who used the facilities and what/how much LTPA they undertook. Customers could choose whether to register socio-demographic details (age, sex, and postcode) during first use. Ethnicity and disability data were not recorded. Registered users had each activity recorded via a swipe card or an online booking. They could either take out a pre-paid/monthly membership (fees paid annually or 6-monthly in advance, or by a monthly direct debit) allowing unlimited use of gym, fitness class and swimming pools, or access the centres on a pay-as-you-go basis (activity fees paid individually at the time of booking). To ensure anonymity for the study, the trust used look-up tables[24] to classify customer postcodes by index of multiple deprivation (IMD) quintile (representing social economic status at area level, with quintile group 5 being the least deprived group and quintile group 1 the most deprived groups).[25] Additionally, the trust replaced customer identification numbers with anonymous study ID numbers prior to data transfer.

Not registering socio-demographic details did not prevent leisure centre use. Non-registered users could access the leisure centres on a pay-as-you-go basis by paying for activities at leisure centre receptions. For this group, payments were not linked to an individual user but recorded as one generic ‘non-member’ user in the FDS. Price level settings ensured that only adult non-registered pay-as-you-go usage was extracted.

2.3 Physical activity classification

Prior to extraction, we conducted 2 scoping workshops with 4 leisure trust staff (chief executive, health and fitness lead, a centre-based fitness manager and an IT specialist) to establish the type and duration of activities available for adults. Further clarification of details took place via email and telephone with the fitness manager and the IT specialist over a 2-week period. We allocated each activity a Metabolic Equivalent of Task (MET) level using the Compendium of Physical Activities.[26] Individual activities were classed as either light (< 3 METs), moderate (3.0-5.9 METs) or vigorous (≥ 6 METs) intensity.[27] For example, we allocated studio cycling a MET value of 8.5 METs and classified it as vigorous activity. We determined activity duration based on timetabled duration of the activity, with the exception of gym and swimming. One leisure site utilised the Technogym MyWellness System (Technogym S.p.A, Cesena, Italy) and reported that 321 individuals had used the system to record their gym-based activity in a 30-day period (01/04/2019-30/04/2019). Leisure trust staff randomly selected and analysed the records of 160 (50%) of these users. The MyWellness system recorded the total amount of time spent using cardiovascular and strength machines (an objective measure of workout time). Median workout time for the group examined was 33.5 (IQR 20-48.75) minutes. We therefore estimated gym activity duration to be a conservative 30 minutes. It was not possible to measure swimming duration objectively; but we applied the same 30-minute workout time, based upon estimates from trust staff. The leisure trust integrated METs values, intensity classification and duration for each activity at the point of data extraction.

2.4 Variables

Our analysis included data for all users that were 18+ years of age between 01/07/2018 and 30/06/2019. The final extract contained membership type (pre-paid/monthly member and

140 registered pay-as-you-go user, non-registered pay-as-you-go user), 10 year age group, sex
141 (male, female), IMD quintile and leisure centre classification (small [limited opening times,
142 e.g. only open after school hours, limited facilities e.g. with one of pool or gym or fitness
143 studio] and large [all day opening, pool, gym, fitness classes]). It also included individual
144 usage data: date, duration, intensity level and type of activity undertaken for every indoor
145 leisure centre attendance. Individual activities were grouped into 5 main activity areas (gym,
146 fitness classes, swimming, health referral and other activities).

147 We calculated the total number of attendances at light, moderate and vigorous activities, and
148 the total duration of activities in each intensity category during the data extract period. Using
149 the first and last usage dates for each user, we created a data field for the maximum number
150 of weeks usage in the 1-year data period. We defined a new measure of leisure centre based
151 LTPA based on the domain defined by Samitz, Egger and Zwaheln (2011) '*leisure time PA*
152 *'recreational activities including callisthenics, dancing, walking, hiking, golf, bicycling,*
153 *swimming, games, exercise and sports*',[17] but limited to LTPA that took place in the leisure
154 centres studied. The total weekly moderate/vigorous leisure centre-based LTPA per user was
155 calculated using:

156 $$\frac{\text{Total duration of moderate activities} + 2(\text{total duration of vigorous activities})}{\text{Max number of weeks' usage in 1-year data period}}$$

158 We then classified all weekly moderate/vigorous leisure centre-based LTPA user scores by
159 World Health Organisation PA category (<30 minutes/week, 30-149 minutes/week and 150+
160 minutes/week).[28]

2.5 Outcomes

We examined descriptive participant characteristics for all registered users and compared registered user demographics with 2018 population estimates provided by Northumberland County Council intelligence team.[29] First, examined total usage/usage by main activity type for prepaid/monthly members, registered pay-as-you-go members and non-registered pay-as-you-go users. Where demographics were available, we also examined usage by gender. In the absence of any data about user numbers, we assumed that non-registered pay-as-you-go usage mirrored registered pay-as-you-go usage in terms of number of visits per person. We therefore calculated the mean number of attendances for registered pay-as-you-go users and divided the number of non-registered pay-as-you-go visits to give an estimate to number of non-registered pay-as-you-go users.

We examined average number of attendances, average length of usage (based on the maximum number of weeks usage data field), weekly moderate/vigorous leisure centre-based LTPA user scores, and categories of PA. Finally, we examined associations of demographic variables with PA categories achieved.

2.6 Statistical analysis

Descriptive analyses of baseline characteristics for registered users were performed using the Pearson χ^2 test for categorical variables (summarized as frequencies/percentages) and compared to adult Northumberland population estimates, 2018.[29] We examined data distribution for total attendance, participants' maximum usage period and weekly moderate/vigorous leisure centre-based LTPA scores using the Kolmogorov-Smirnov test and calculated median usage periods and LTPA scores for pre-paid/monthly and registered pay-as-you-go members. Ordinal regression models were utilized to evaluate the association

between demographic variables (sex, age groups, IMD quintiles, locations) and categorical weekly leisure-centre based PA (<30 minutes/week, 30-149 minutes/week and 150+ minutes/week) for pre-paid/monthly members by using PA less than 30 minutes /week as the reference group. Subgroup analyses were stratified by sex. We chose ordinal regression models because PA categories were ranked from low to high, which is a natural ordering class. The proportional odds assumption for ordinal regression models were tested and not violated. Odds ratios (ORs) with 95% confidence intervals were reported. Two-sided P values for all tests were calculated with $p<0.05$ considered significant. All statistical analyses were performed using R version 3.5.1 (Free Software Foundation, Boston, USA).

3 Results

3.1 Registered participant characteristics

In total, 20,904 registered users attended the leisure facility centres between 01/07/2018 and 30/06/2019, representing 8.1% of the Northumberland adult population. Registered users were more likely to be female (58.7%), younger (23.9% of users were aged 18-29 years compared to 10.1% of those aged 70+ years) and from the two most affluent IMD quintiles (53.7%) (Table 1).

INSERT Table 1

3.2 Attendance and type of activity choices

Users attended 1,085,037 activity sessions in the data period, with the most popular types being the gym (n=387,133, 35.7% of activities) and fitness classes (n=367,812, 33.9% of activities). The number of activities undertaken is not an indicator of the number of visits, as some users took part in multiple activities during visits, (e.g. used the gym and then went swimming). The majority of usage was by pre-paid/monthly members (75.8%) (Table 2).

INSERT Table 2

Overall, 24.2% of usage was on a pay-as-you-go basis. Non-registered pay-as-you-go usage (those with no details registered who paid for activities at the point of attendance) was an important component of this (16.9% of overall usage), being 2.3x higher than registered pay-as-you-go member usage (those with details registered who paid for activities at the time of booking) (7.3% of overall usage). For the non-registered group, the most popular activity was swimming (n=155,065, 84.5% of activities).The mean number of attendances per registered pay-as-you-go user was 10.6 (SD ±17.8). We presumed that non-registered pay-as-you-go users attended a similar number of times to registered pay-as-you-go members. As the total non-registered pay-as-you-go usage attendance of 183,440, we estimated there were 17,305 (183,440/10.6) non-registered pay-as-you-go participants who used the leisure centres during the 1-year period, giving an estimated 38,159 adult leisure centre users (14.7% of the Northumberland population).

3.3 Attendance and activity choices of registered users by sex

Females accounted for 57.4% of all registered usage, with the most popular female activity being fitness classes (59.3% of female visits). This was consistent for both pre-paid/monthly members (58.6% of female visits) and registered pay-as-you-go users (66.3% of female visits). The most popular male activity was the gym (65.7% of visits). For male pre-paid/monthly members, the most popular activity was the gym (69.5% of male visits), while for registered pay-as-you-go users, other activities (5-a-side football, badminton, squash, table tennis) were the most popular choice (36.5% of male visits) (Table 3).

INSERT Table 3

3.4 Overall attendance and maximum weeks usage for registered users

The median number of attendances for registered users in the 1-year data period was 20 (IQR 4.0-59.8) and the median number of weeks that participants used the leisure centres was 29 (IQR 5.0-4.9). Pre-paid/monthly members attended more often (median 41.0 attendances, IQR 15.0-84.0) ($p<0.001$), over a longer period of time (median 44.0, weeks IQR 15.0-51.0 weeks) (Table 4).

INSERT Table 4

As the median attendance and number of weeks usage for registered pay-as-you-go members was so short (4.0 weeks, IQR 1.0-25.0), in the following results we present a more detailed analysis for pre-paid/monthly members only.

3.5 Weekly moderate/vigorous leisure centre-based LTPA for pre-paid/monthly members

Median weekly moderate/vigorous leisure centre-based LTPA was 55 (IQR 30-99) minutes/week for pre-paid/monthly members. This equated to approximately 1/3 of the recommended 150 minutes of moderate/vigorous weekly PA. Some pre-paid/monthly members (n=1,729, 12.9%) achieved the World Health Organisation recommended levels of PA through leisure centre use alone. Females were more likely to achieve 150 minutes of moderate/vigorous PA by leisure centre use than males (18.9% vs 5.8%) (Table 5).

INSERT Table 5

Being female, older and attending a large leisure significantly increased the odds of achieving a higher category of PA (30-149 minutes and ≥150 minutes) compared with undertaking <30 minutes of activity per week through leisure centre based activity. In the sex-stratified analysis, for both sexes being older and attending a large leisure centre significantly increased the odds of achieving a higher category of PA compared to undertaking <30 minutes of PA. Women living in deprived areas had increased odds of higher activity categories compared to

those in more affluent areas, but conversely, for men, living in a more affluent area decreased had decreased odds of achieving higher physical activity categories (Table 6).

INSERT Table 6

4 Discussion

4.1 Main finding of this study

In this large population-based study, our results demonstrated that the provision of local authority leisure centres contributed a median of 55 minutes (IQR 30-99) of moderate/vigorous LTPA per week to the recommended ≥150 minutes of moderate/vigorous PA per week. This means that local authority leisure centre members achieve approximately 1/3 of the World Health Organisation recommended 150 minutes of moderate/vigorous weekly PA[12] through leisure centre use. This is an important contribution, which should be combined with encouragement for users to be active in other environments to achieve the recommended levels of PA. Importantly, our findings identified that being female, being older and attending a large leisure centre significantly increased the odds of achieving a higher category of physical activity (30-149 minutes and ≥150 minutes) compared with undertaking <30 minutes of activity per week through leisure centre based activity.

A positive finding of this study was that females were disproportionately more likely to engage in local authority leisure centre activity, reflecting UK public sector insight[30] and potentially addressing previously observed sex-based PA inequalities.[31] This is particularly important since 43% of activity inequality, as identified in a study of mobile telephone step data from 111 countries, was explained by sex.[32] Local authority leisure centres are therefore a potentially important intervention to encourage LTPA for women. From the activity data in our study, it is clear that female users preferred to take part in predominantly non-

competitive, group-based fitness activities (58.6% of all female member activity). Much research and policy has focused on understanding sex-based inequity in sport and encouraging female sports participation.[33] However, studies indicate that making physical education more enjoyable by increasing choice and offering a wide range of non-competitive activities leads to successful interventions to increase PA in girls.[34] Our results indicate that the availability of group fitness classes, which tend to be non-competitive and emphasise the fun element of PA, may be the reason why leisure centre-based LTPA appeals to women. Qualitative research is required to gain insight into female activity preferences in a leisure centre environment in order to develop more suitable activity options. In particular, studies are required to understand why the gym environment lacks appeal to many women and whether it is possible to address low-usage.

We identified that 8.1% of the Northumberland population were registered users of the local authority leisure centres and 65% of these (5.2% of Northumberland population) were prepaid/monthly members. We estimated that 14.7% of the adult Northumberland population accessed Northumberland local authority leisure centres in the year studied. The 2019 State of the U.K. Fitness Industry Report revealed that 15.6% of the U.K. adult population are now members of a gym.[19] In Northumberland, the 5.2% level of pre-paid/monthly memberships is similar to the U.K. national average of 5.1% with a membership at a publically owned facility. Unlike many other areas of the U.K., however, Northumberland has no multisite private fitness provider within the county. Nationally, small independent fitness facility operators account for only 20% of fitness memberships (3.1% of the U.K. population),[19] indicating that even if independent operators have expanded to fill some of the market occupied elsewhere by large gym chains, there is likely to be latent demand for fitness usage in Northumberland. The ability to 'pay-as-you-go' appears to be an important element of

local authority leisure provision in the county, accounting for 24.2% of use. This is one of the benefits of public sector provision, but better understanding of these users is required. Registered pay-as-you-go members had a much shorter median usage period (4 weeks [IQR 1.0-25.0]), making them a group to target for maintained engagement. There was also a large group of users where data are lacking (non-registered pay-as-you-go users). This group accounts for 16.9% of usage, but we were only able to estimate number of users and had no information about demographics. Due to a lack of comparable studies, we are unable to comment on whether this issue is specific to Northumberland. We encourage other providers to examine these data. Encouraging or incentivising this group to register details would increase understanding.

Our analysis indicated that, compared with the Northumberland population those who were older were less likely to use the local authority leisure centres, but where they did engage they were more likely to achieve the recommended PA levels[12] through leisure centre use than younger people. This highlights the potential for local authority leisure centres to increase PA for older populations if they can be encouraged to engage. Since Northumberland population projections indicate that 31% of residents will be over 65 by 2031,[35] provision must be made appealing and accessible to those who are older. It is unclear why a large proportion of the older population in Northumberland do not currently access the local authority leisure centres, but it is possible that older people do not consider the facilities to be easily accessible, activities to be appropriate, or attended by others of a similar age, all factors rated as important among older adults.[36] Furthermore, a primary factor in encouraging older people to take part in PA is identified as being motivated by the social environment,[37] indicating that the social aspect of activities is likely to be an important element in future provision for older people. Finally, a previous evaluation of the exercise referral scheme in

Northumberland reported that this intervention was more successful in those aged over 55 years,[38] suggesting that building on this type of programme may lead to increased access for those who are older.

We also reported that those from more deprived areas were less likely to access the local authority leisure centres. As those living in more deprived areas have potentially less disposable income, it is possible that price is a contributing barrier to access but we were unable to examine the effect of concession pricing, as in the period covered by the data extract the trust made changes to their concessionary access scheme. This was further complicated by the way that memberships were tagged in the FDS, with the term concessionary applied to any discounted membership, rather than just to those on low incomes or who were registered disabled. Pricing in the local authority leisure sector to encourage use by targeted groups is complex. Quantitative studies have reported that offering free memberships can increase participation, [20 21 39 40] but that if free use is removed, then usage is not always maintained.[39] Of interest, in the current study, the majority of exercise referral usage was on a pay-as-you go basis. Given that those who took out prepaid/monthly memberships used the centres for a much longer period, the leisure trust should explore how to encourage a move from pay-as-you-go to pre-paid/monthly membership for this group as it may have the potential to improve retention. A caveat for this must be that pricing strategies do not exclude those in who are in the lowest income brackets. Qualitative evidence indicates that navigating the competing pressures of providing services for public 'good' and remaining commercially viable makes pricing decisions difficult, and that pricing is only one barrier for accessing facilities.[41] While recognising the complexities, in the case of this leisure trust ensuring that concession pricing is clearly defined and accurately tagged within the FDS would enable future examination of the effect of pricing strategies.

4.2 Strengths and weakness of this study

The strength of this study is the novel analysis that used individual level data of attendance at local authority leisure centres over a one-year period and combined it with intensity levels of activities attended, to create a new measure of weekly leisure centre-based LTPA. This provides a more robust analysis than self-reported surveys as it can be done at large scale, and does not involve participant recall, thereby eliminating inaccurate memory, social desirability and direct prompting by questionnaires.[42] The measure is still subject to some estimation of actual LTPA achieved and does not account for weeks where holiday or illness are the reason for non-attendance. We are unaware of any previously published research that has attempted to quantify leisure centre-based activity in this way. FDS providers could integrate the method presented in this paper into the setup of FDSs and their associated reporting systems to allow for regular reporting of these type of data.

Measuring attendance using FDS data may be subject to error. Users may not swipe their membership card to record an activity when entering a facility. Additionally, they may choose to do another activity while onsite without booking, may leave an activity early or may book online and then decide not to attend the activity. Due to limitations on numbers in fitness classes, these are the most likely to be pre-booked and therefore most prone to error using our methodology. This trust had identified an issue with non-attendance at fitness classes after booking, but staff mitigated this to an extent by checking attendance due problems with waiting lists for sessions. Participant who booked 3 sessions and did not attend had booking privileges removed for 2 weeks. This will have reduced, but not eliminated potential problems with non-attendance.

4.3 Implications of this study

Leisure centre provision in Northumberland accounted for pre-paid/monthly members achieving 55 of the recommended 150 minutes of moderate/vigorous weekly PA for a median of 44 weeks per year. This is a valuable contribution, but leisure providers could also work with public health teams to develop and promote positive messages about PA outside leisure centre visits to ensure that users achieve sufficient PA to benefit health. Since the median period of usage for registered pay-as-you-go members was only 4 weeks, these users need targeting within a few weeks of their first usage with long-term membership offers that are accessible to all. Investment in attracting and retaining users from groups known to have the greatest PA inequalities (women, older people and those more deprived areas) can be an important population health approach.

Further qualitative research should attempt to understand what explains these findings, and how this information could be used to deliver more accessible and effective leisure centre provision. Given that this study examines data from only one area of England, future studies are required to understand if findings same or different globally.

5 Conclusion

Using this novel measure of local authority leisure centre attendance, we demonstrated that usage contributed a median of 55 minutes (IQR 30-99) of moderate/vigorous LTPA per week to the recommended ≥150 minutes of moderate/vigorous PA per week and that older adults and female participants were more likely to achieve the recommended PA levels. FDS providers could integrate the method into systems to provide industry-wide data, which would lead to an understanding of how publically and privately owned fitness facilities contribute to addressing physical activity inequalities.

Acknowledgements The authors thank Mark Tweedie and Amy Wegrzyn-Miller for their support in data collection and providing contextual information.

Funding This study had no external funding.

Competing interests JB is employed by Active Northumberland and was involved in providing information about the nature of activities and providing contextual information upon request when interpreting results.

References

1. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *Lancet.* 2012;**380**(9838):219-229. doi: 10.1016/S0140-6736(12)61031-9
2. Nocon M, Hiemann T, Müller-Riemenschneider F, Thalau F, Roll S, Willich SN. Association of physical activity with all-cause and cardiovascular mortality: a systematic review and meta-analysis. *Eur J Cardiovasc Prev Rehabil.* 2008;**15**(3):239-246. doi: 10.1097/HJR.0b013e3282f55e09
3. Jeon CY, Lokken RP, Hu FB, van Dam RM. Physical Activity of Moderate Intensity and Risk of Type 2 Diabetes: A systematic review. *Diabetes Care.* 2007;**30**(3):744-752. doi: 10.2337/dc06-1842
4. Schottenfeld D, Beebe-Dimmer JL, Buffler PA, Omenn GS. Current Perspective on the Global and United States Cancer Burden Attributable to Lifestyle and Environmental Risk Factors. *Annu Rev Public Health.* 2013;**34**(1):97-117. doi: 10.1146/annurev-publhealth-031912-114350
5. Harriss DJ, Atkinson G, Batterham A, et al. Lifestyle factors and colorectal cancer risk (2): a systematic review and meta-analysis of associations with leisure-time

physical activity. *Colorectal Dis.* 2009;**11**(7):689-701. doi: 10.1111/j.1463-1318.2009.01767.x

6. Hunter RF, Boeri M, Tully MA, Donnelly P, Kee F. Addressing inequalities in physical activity participation: Implications for public health policy and practice. *Prev Med.* 2015;**72**:64-69. doi: 10.1016/j.ypmed.2014.12.040

7. Lowe M, Whitzman C, Giles-Corti B. Health-Promoting Spatial Planning: Approaches for Strengthening Urban Policy Integration. *Planning Theory & Practice.* 2018;**19**(2):180-197. doi: 10.1080/14649357.2017.1407820

8. White RL, Babic MJ, Parker PD, Lubans DR, Astell-Burt T, Lonsdale C. Domain-Specific Physical Activity and Mental Health: A Meta-analysis. *Am J Prev Med.* 2017;**52**(5):653-666. doi: 10.1016/j.amepre.2016.12.008

9. World Health Organisation. *Global status report on noncommunicable diseases "Attaining the nine global noncommunicable diseases targets; a shared responsibility".* Geneva: World Health Organisation; 2014. Available at: https://www.who.int/publications/i/item/9789241564854. [Accessed June 10, 2020]

10. World Health Organisation. Global Health Observatory (GHO) data Prevalence of insufficient physical activity. Website. https://www.who.int/gho/ncd/risk_factors/physical_activity/en/. Updated November 5, 2018. Accessed June 10, 2020.

11. World Health Organisation. *Physical Activity Factsheets for the 28 European Union Member States of the WHO European Region.* Copenhagen: World Health Organisation Regional Office for Europe; 2018. Available at: http://www.euro.who.int/en/health-topics/disease-prevention/physical-activity/publications/2018/factsheets-on-health-enhancing-physical-activity-in-the-28-eu-member-states-of-the-who-european-region. [Accessed June 11, 2020]

12. World Health Organisation. *Global recommendations on physical activity for health.* Geneva: World Health Organisation; 2010. Available at: https://www.who.int/publications/i/item/global-recommendations-on-physical-activity-for-health. [Accessed June 11, 2020]

13. British Heart Foundation. *Physical Inactivity and Sedentary Behaviour Report 2017*. UK: British Heart Foundation; 2017. Available at: https://www.bhf.org.uk/informationsupport/publications/statistics/physical-inactivity-report-2017. [Accessed June 11, 2020]

14. Public Health England. *Health matters: getting every adult active every day*. London: Public Health England; 2016. Available at: https://www.gov.uk/government/publications/health-matters-getting-every-adult-active-every-day/health-matters-getting-every-adult-active-every-day. [Accessed June 11, 2020]

15. Sport England. Active Lives Online. Website. https://activelives.sportengland.org/. Updated 2019. Accessed November 19, 2019.

16. Sofi F, Capalbo A, Cesari F, Abbate R, Gensini GF. Physical activity during leisure time and primary prevention of coronary heart disease: an updated meta-analysis of cohort studies. *Eur J Cardiovasc Prev Rehabil.* 2008;15(3):247-257. doi: 10.1097/HJR.0b013e3282f232ac

17. Samitz G, Egger M, Zwahlen M. Domains of physical activity and all-cause mortality: systematic review and dose–response meta-analysis of cohort studies. *International J Epidemiology.* 2011;**40**(5):1382-1400. doi: 10.1093/ije/dyr112

18. Hupin D, Roche F, Gremeaux V, et al. Even a low-dose of moderate-to-vigorous physical activity reduces mortality by 22% in adults aged >= 60 years: a systematic

review and meta-analysis. *Br J Sports Med.* 2015;**49**(19). doi: 10.1136/bjsports-2014-094306

19. LeisureDB. *The 2019 UK Fitness Industry Report.* London: LeisureDB; 2019.

20. Higgerson J, Halliday E, Ortiz-Nunez A, Brown R, Barr B. Impact of free access to leisure facilities and community outreach on inequalities in physical activity: a quasi-experimental study. *J Epidemiol Community Health.* 2018;**72**(3):252-258. doi: 10.1136/jech-2017-209882

21. Verhoef T, Robinson N, Fox P, Morris S. Cost-effectiveness analysis of offering free leisure centre memberships to physically inactive members of the public receiving state benefits: a case study. *BMC Public Health.* 2016;**16**(1):616. doi: 10.1186/s12889-016-3300-x

22. Northumberland County Council. Northumberland Knowledge and JSNA, Topics Population. Website https://www.northumberland.gov.uk/Northumberland-Knowledge-and-JSNA/Our-People/People.aspx. Updated No date. Accessed June 10, 2020.

23. Public Health England. *Northumberland Local Authority Health Profile 2019.* London: Public Health England; 2020. Available at: https://fingertips.phe.org.uk/profile/health-profiles. [Accessed June 11, 2020]

24. Ministry of Housing Communities and Local Government. English Indices of Deprivation 2019, Northumberland. Website. http://imd-by-geo.opendatacommunities.org/imd/2019/area57. Updated 2019. Accessed June 10, 2020.

25. McLennan D, Noble S, Noble M, Plunkett E, Wright G, Gutacker N. *The English Indices of Deprivation 2019 Technical Report.* UK: Ministry of Housing, Communities and Local Government; 2019

26. Healthy Lifestyles Research Center. Compendium of Physical Activities. Arizona State University. Website. https://sites.google.com/site/compendiumofphysicalactivities/home. Updated No date. Accessed February 14, 2020.

27. Ainsworth BE, Haskell WL, Whitt MC, et al. Compendium of Physical Activities: an update of activity codes and MET intensities. *Medicine & Science in Sports & Exercise.* 2000;**32**(9).S498-S156

28. World Health Organisation, *WHO STEPS surveillance manual : the WHO STEPwise approach to chronic disease risk factor surveillance*, Geneva, Switzerland: World Health Organisation; 2005

29. Rowe S. *Northumberland index of multiple deprivation and adult 10 year age group statistics 2018.* Northumberland: Northumberland County Council; 2020

30. UK Active Research Institute. *Moving Communities: Active Leisure Trends 2019 Report.* UK: UK Active Research Institute; 2019.

31. Health and Social Care Information Centre *Health Survey for England 2012 Health, social care and lifestyles. Summary of key findings*. Leeds: Health and Social Care Information Centre; 2013

32. Tim A, Rok S, Jennifer LH, Abby CK, Scott LD, Jure L. Large-scale physical activity data reveal worldwide activity inequality. *Nature.* 2017;**547**(7663). doi: 10.1038/nature23018

33. Mansfield L, Caudwell J, Wheaton B, Watson B. *The Palgrave Handbook of Feminism and Sport, Leisure and Physical Education.* London: Palgrave Macmillan; 2018.

34. Camacho-Miñano MJ, LaVoi NM, Barr-Anderson DJ. Interventions to promote physical activity among young and adolescent girls: a systematic review. *Health Ed Res.* 2011;**26**(6):1025-1049. doi: 10.1093/her/cyr040

35. Jamieson M. *Population & Household Projections for Northumberland. Comparing projections by ONS and Northumberland County Council (using Popgroup model)* Northumberland: Northumberland County Council; 2013.

36. Cohen-Mansfield J, Marx MS, Biddison JR, Guralnik JM. Socio-environmental exercise preferences among older adults. *Prev Med.* 2004;**38**(6):804-811. doi: 10.1016/j.ypmed.2004.01.007

37. Dedeyne L, Dewinter L, Lovik A, Verschueren S, Tournoy J, Gielen E. Nutritional and physical exercise programs for older people: program format preferences and (dis)incentives to participate. *Clin Interv Aging.* 2018;**13**:1259-1266. doi: 10.2147/CIA.S159819

38. Hanson CL, Allin LJ, Ellis JG, Dodd-Reynolds CJ. An evaluation of the efficacy of the exercise on referral scheme in Northumberland, UK: association with physical activity and predictors of engagement. A naturalistic observation study. *BMJ Open.* 2013;**3**(8). doi: 10.1136/bmjopen-2013-002849

39. Bullough S, Davies LE, Barrett D. The impact of a community free swimming programme for young people (under 19) in England. *Sport Manag Rev.* 2015;**18**(1):32-44. doi: 10.1016/j.smr.2014.09.001

40. Frew EJ, Bhatti M, Win K, et al. Cost-effectiveness of a community-based physical activity programme for adults (Be Active) in the UK: an economic analysis within a natural experiment. *Br J Sports Med.* 2014;**48**(3):207. doi: 10.1136/bjsports-2012-091202

538 41. Halliday E, Barr B, Higgerson J, Holt V, Ortiz-Nunez A, Ward F. Using local
539 authority entrance charges to tackle inequalities in physical activity? A qualitative
540 study of leisure and public health perspectives. *J Public health (Oxf).* 2018;**40**(3):567.
541 doi: 10.1093/pubmed/fdx124

542 42. Brenner, P.S. and J.D. DeLamater, Social Desirability Bias in Self-reports of Physical
543 Activity: Is an Exercise Identity the Culprit? Social indicators research, 2013. 117(2):
544 p. 489-504.

545 **Table 1:** Registered user characteristics compared to the Northumberland adult population

546 between July 2018 and June 2019.

Characteristic	All registered users (n=20,904)		Pre-paid/monthly Members (n=13,407)		Registered pay-as-you-go members (n=7,497)		Adult Northumberland Population 2018 (n=259,631)	
	n	(%)	n	(%)	n	(%)	n	(%)
Sex**								
Male	8,662	(41.3)	6,143	(45.8)	2,519	(33.6)	125,375	(48.1)
Female	12,237	(58.7)	7,263	(54.2)	4,974	(66.3)	135,018	(51.9)
Age group**								
18-29	4,986	(23.9)	3,180	(23.7)	1,806	(42.1)	36,942	(14.2)
30-39	3,530	(16.9)	2,138	(15.9)	1,392	(18.6)	34,706	(13.4)
40-49	3,591	(17.2)	2,264	(16.9)	1,327	(17.7)	38,399	(14.8)
50-59	3,619	(17.3)	2,448	(18.3)	1,171	(15.6)	50,055	(19.3)
60-69	3,067	(14.7)	2,084	(15.5)	983	(13.1)	46,029	(17.7)
70+	2,111	(10.1)	1,293	(9.6)	818	(10.9)	53,500	(20.6)
IMD quintile* (2015)								
IMD 1	2,738	(13.0)	1,754	(13.1)	984	(13.1)	42,083	(16.2)
IMD 2	3,580	(17.2)	2,216	(16.5)	1,364	(18.2)	49,952	(19.2)
IMD 3	2,713	(13.2)	1,775	(13.2)	938	(12.5)	66,080	(25.5)
IMD 4	5,367	(26.2)	3,519	(26.2)	1,848	(24.6)	47,980	(18.5)
IMD 5	5,663	(27.5)	3,692	(27.5)	1,971	(26.3)	54,009	(20.8)
Not Stated	843	(4.0)	451	(3.4)	392	(5.2)		
Leisure centre classification^**								
Small	1,225	(5.9)	703	(5.2)	522	(7.0)		
Large	19,654	(94.0)	12,704	(94.8)	6,950	(92.7)		
Not stated	25	(0.1)			25	(0.3)		

^***Leisure centre classification:*** *small (limited opening times, limited facilities e.g. with one of pool or gym or fitness studio) large (all day opening, pool, gym, fitness classes), *p<0.05, **p<0.001*

547

548

549 **Table 2:** All users' attendance and activity choices.

Type of activity	Attendances(times)	% of usage
All users (n= not known)		
Gym	387,133	35.7
Fitness classes	367,812	33.9
Swimming	268,210	24.7
Health referral	33,376	3.1
Other**	28,506	2.6
Total Usage	**1,085,037**	
Pre-paid/monthly Members (n=13,407)		
Gym	367,843	44.7
Fitness classes	322,601	39.2
Swimming	106,724	13.0
Health referral	21,031	2.6
Other**	4,319	0.5
Total Usage	**822,518**	
Registered pay-as-you-go members (n=7,497)		
Gym	9,157	11.6
Fitness classes	38,117	48.2
Swimming	6,421	8.1
Health referral	11,315	14.3
Other**	14,069	17.8
Total Usage	**79,079**	
Non-registered pay-as-you-go users (n=not known)		
Gym	10,133	5.5
Fitness classes	7,094	3.9
Swimming	155,065	84.5
Health referral	1,030	0.6
Other**	10,118	5.5
Total Usage	**183,440**	

**Other: 5-a-side football, badminton, squash, table tennis*

550

551

552 **Table 3:** Sex stratified analysis of usage and activity choice for registered users

	Female		Male	
Type of activities	**Attendances**	**% of usage**	**Attendances**	**% of usage**
Overall	(n=12,237)		(n=8662)	
Gym	125,170	24.2	251,829	65.7
Fitness Classes	307,145	59.3	53,524	13.9
Swimming	62,250	12	50,895	13.3
Health Referral	18,880	3.6	13,466	3.5
Other*	4,654	0.9	13,722	3.6
Total Usage	**518,099**		**383,436**	
Pre-paid/monthly members	(n=7623)		(n=6143)	
Gym	121,838	26	246,004	69.5
Fitness Classes	274,537	58.6	48,015	13.5
Swimming	58,520	12.5	48,204	13.6
Health Referral	12,492	2.6	8,539	2.4
Other*	1,501	0.3	2,818	1
Total Usage	468,888		353,580	
Registered pay-as-you-go users	(n=4,974)		(n=2,519)	
Gym	3,332	6.8	5,825	19.5
Fitness Classes	32,608	66.3	5,509	18.5
Swimming	3,730	7.5	2,691	9
Health Referral	6,388	13	4,927	16.5
Other*	3,153	6.4	10,904	36.5
Total Usage	49,211		29,856	

**Other: 5-a-side football, badminton, squash, table tennis*

553

554

Table 4: Overall attendance and maximum weeks usage for registered members

	All registered users (n=20,904)		**Pre-paid/monthly Members (n=13,407)**		**Registered pay-as-you-go members (n=7,497)**	
	Median	IQR	Median	IQR	Median	IQR
No. of attendances	20.0	4.0-59.8	41.0	15.0-84.0	3.0	1.0-12.0
Maximum weeks usage	29.0	5.0-49.0	44.0	15.0-51.0	4.0	1.0-25.0

Table 5: *Level of weekly PA by category for pre-paid/monthly members*

Activity Category	**All members (n=13407)**		**Females (n=7263)**		**Males (n=6143)**	
	n	%	n	%	n	%
Less than 30 minutes per week	3288	24.5	1471	20.3	1817	29.6
30 - 149 minutes per week	8390	62.6	4422	60.9	3967	64.6
150+ minutes per week	1729	12.9	1370	18.9	359	5.8

Table 6: Ordinal regression modelling for categorical weekly leisure centre-based PA for pre-paid/monthly members (n=13,407) between 01/07/2018 and 30/06/2019.

	All pre-paid/monthly members (n=13,407)	**Female pre-paid/monthly members (n=7623)**	**Male pre-paid/monthly members (n=6143)**
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex	2.09 (1.95-2.35)**		
Age group	1.14 (1.11-1.16)**	1.13 (1.10-1.17)**	1.14 (1.06-1.18)**
IMD quintile	0.98 (0.96-1.00)	1.03 (1.00-1.06)*	0.91 (0.87-0.94)**
Leisure centre category	1.21 (1.03-1.42)*	1.37 (1.10-1.71)**	0.99 (0.79-1.24)

Age group*: young age as reference;* ***IMD****: most deprived quintile as reference;* ***Leisure centre category****: small leisure centre as reference group;* ***Sex****: male as the reference *<0.05 **<0.000*