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The impact of free access to swimming pools on children’s participation in swimming. A comparative regression discontinuity study.

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ABSTRACT

Objective. Investigating the extent to which providing children with free swimming access during school holidays increased participation in swimming and whether this effect differed according to the socioeconomic deprivation of the neighbourhoods in which children lived.

Setting: A highly disadvantaged local authority (LA) in North West England.

Intervention: Provision of children with free swimming during the summer holidays.

Outcome measures: Number of children swimming, and the number of swims, per 100 population in 2014.

Design. Comparative regression discontinuity investigating the extent to which participation rates amongst children aged 5-15 were greater in the intervention LA compared to a similar control LA. We estimated the differential effect of the intervention across five groups, defined by quintiles of area deprivation.

Results. Free swimming during the summer holidays was associated with an additional 6% of children swimming (95% CI 4% to 9%) and an additional 33 swims per 100 children per year (95% CI 21 to 44). The effects were greatest in areas with intermediate levels of deprivation (quintiles 3 and 4) within this deprived LA.

Conclusion. Providing free facilities for children in disadvantaged areas is likely to increase swimming participation and may help reduce inequalities in physical activity.

Key words: Physical activity, policy, inequalities, leisure, pricing

Word count: 3045.

1 BACKGROUND

2 Since the 19th century local authorities in the UK have been providing subsidised baths or swimming
3 pools for public use. (1) The social benefits of these facilities, including social inclusion, community
4 wellbeing and public health have often been used to justify this subsidy. (2) Whilst initially the
5 introduction of public baths was seen as a way of improving public cleanliness, today they are
6 increasingly seen as assets for promoting physical activity.(1) A lack of physical activity is a major
7 public health concern as one in every three children in England is obese by the time they are 10
8 years old. (3) Children in the most deprived parts of the country are twice as likely to be obese and
9 these inequalities are increasing. (3) Levels of physical activity amongst children in the UK are low
10 with only 16% of girls and 21% of boys achieving the recommended level (3). The relationship
11 between children’s physical activity and levels of deprivation is less clear, with some studies
12 showing lower levels in more disadvantaged groups and others showing no relationship with
13 deprivation.(4–7) Increasing physical activity amongst children from deprived neighbourhoods is
14 however an important strategy for addressing health inequalities.

15 Many local authorities, therefore, use public money to ensure the cost of using swimming pools is
16 affordable, often providing free or concessionary rates for children. With increasing cuts to local
17 government budgets, these schemes are at risk. Between 2009 and 2014 the public subsidy for local
18 authority leisure facilities was cut by 32% from £550 million to £375 million.(8) Many councils are
19 now seeking to pass on the full cost of providing leisure services to the users, removing subsidies
20 altogether - ending the historic public investment in these facilities for social benefit.(9)

21 Between March 2009 and July 2010 the UK government subsidised free swimming for all children
22 across the country. This scheme was ended early as part of the government’s austerity package to
23 reduce public spending.(10) Some councils, however, continued to provide free swimming for
24 children. Analysis of uptake of the scheme in Bristol found no relationship between area deprivation
25 and uptake of the offer, but larger distances to facilities and the winter season were both associated
26 with lower participation in deprived areas. (11) Many local authorities are also considering whether
27 to invest their public health budgets in subsidising leisure facilities. There is, however, limited
28 evidence indicating the extent to which free swimming schemes increase participation, and whether
29 this effect differs between socioeconomic groups. The limited robust evidence reflects the difficulty
30 of investigating the impact of public health interventions that are applied universally across
31 populations and as such are not amenable to traditional trial methodologies.

32 We therefore used a quasi-experimental approach – comparative regression discontinuity - to
33 estimate the impact on participation in swimming of a free offer for children in one of the most
34 deprived local authority areas in England and investigated whether this had a differential effect
35 between socioeconomic groups within that local authority.

36 METHODS

37 Setting.

38 Blackpool is a deprived local authority in the North West of England with a population of 142,065 in
39 the 2011 census. In 2015 it was ranked as the 4th most deprived area out of all 326 lower tier local
40 authorities in England.

1 **The intervention.**

2 Blackpool Borough Council provides free use of its two swimming pools for children under 16 years
3 old during the school holidays. The council has funded this free offer since 2010 when the national
4 free swimming scheme for children ended. We investigated the impact of this free offer to children
5 in Blackpool in 2014.

6 **Comparator.**

7 The comparison area used in this study was a similar local authority in the North West of England
8 which ended its free swimming offer to children when the national programme ceased in July 2010.
9 There was no free access to swimming pools for children in the comparison local authority in 2014.
10 The population served by the comparison local authority is similar to Blackpool in terms of
11 deprivation and the age and ethnicity of the population (see Table 1), whilst there were more
12 swimming pools in the comparison local authority the average distance people had to travel to their
13 nearest swimming pool was similar (Table 1).
14

15 **Table 1. Key information on deprivation, demography and leisure facilities for Blackpool and the**
16 **comparison local authority**

	Blackpool	Comparison local authority
Indices of Multiple Deprivation 2015	42	41
% from black and ethnic minority groups	3%	3%
% population under 16	18%	18%
Number local authority leisure facilities with swimming pools	2	4
Average distance (KM) to a swimming pool.	1.6	1.6

17

18 **Dataset, outcomes and variables.**

19 We extracted data from the leisure management IT system for Blackpool and the comparison local
20 authority for every attendance at local authority swimming pools in 2014 for all people aged
21 between 5 and 40 years of age. Data included the type of activity (i.e. swimming), the date and time
22 of the attendance, any cost associated with the attendance, an anonymised person identifier and
23 their age, sex and postcode of residence. To access swimming pools in both of the local authorities,
24 residents – including children - are issued with a personal swipe card and data is automatically
25 recorded on the leisure management system when they attend for a swim. Both local authorities
26 used the same leisure management IT system (Gladstone MRM). Postcode data were linked to data
27 on the Indices of Multiple Deprivation (IMD)(12) using the Lower Super Output Area (LSOA) of
28 residence. The Indices of Multiple Deprivation are a combined measure of the average population
29 and environmental characteristics of areas based on 37 separate indicators, organised across seven
30 distinct domains (income, employment, education, environment, health, crime and housing).(12)
31 LSOAs are small geographical areas with a population of about 1500, used for the publication of

1 various area-based statistics by the Office for National Statistics (ONS). We categorised the IMD
2 score into five groups (quintiles) of equal population size within the two study local authorities. All
3 the LSOAs in the study local authorities were within the 70% most deprived areas nationally, and the
4 most deprived 20% of LSOAs (quintile 5), were all within the most deprived 2% of areas in the
5 country.

6 We calculated two outcomes. Firstly, rates of people swimming were calculated for single year age
7 groups within each deprivation group for the two local authorities as the number of people
8 swimming at least once in the year per 100 population, using 2014 population estimates from the
9 ONS. Secondly swimming attendance rates were calculated as the number of swims per 100
10 population. We calculated these rates using data covering the whole year (1st January – 31st
11 December 2014) and not just the school holidays, because it is possible that the free offer in school
12 holidays resulted in displacement of activity from term time to the holidays. By including data from
13 the whole year we account for any displacement in calculating the overall effect of the intervention.

14 **Analysis.**

15 Regression discontinuity (RD) is widely used to produce causal estimates, where a Randomised
16 Controlled Trial (RCT) is not possible. RD designs have been shown to produce valid estimates when
17 compared to RCTs (13,14), and there is growing evidence of its applicability for public health
18 research across diverse settings (15). RD analysis is used when exposure to an intervention is based
19 on a cut-off point on some continuous measure – referred to as the assignment variable. In the case
20 of the free swimming intervention in this study, the assignment variable is age and the cut-off is 16.
21 RD methods are then used to compare how outcomes vary between those just above and just below
22 this threshold. Conditional on the relationship between the assignment variable and the outcome,
23 exposure to the policy at the cut-off point is as good as random.(16) RD however has a number of
24 weaknesses, including low statistical power and the need to accurately specify the functional form
25 that describes the relationship between the assignment variable (age in our case) and the outcome
26 in the absence of the intervention. The estimates from RD are also only valid for people just above
27 or below the threshold and may not be generalizable to other groups. To mitigate these three
28 weaknesses we use the Comparative RD(CRD) approach proposed by Wing and Cook(17) . This
29 involves comparing the discontinuity within the intervention population (Blackpool) with the
30 variation in the outcome across the assignment variable in a similar population not exposed to the
31 intervention. Unlike in RD, using CRD we can estimate how swimming participation in children is
32 likely to vary with age in the absence of the intervention by using the data from the comparison local
33 authority. This provides an estimate of effect over all ages from 5 to 15, not just at the 15 year old
34 threshold as in an RD design. The CRD provides greater statistical power, than an RD design as it
35 includes data form both and intervention and comparison population – effectively increasing the
36 sample size.

37 Firstly we estimated how each of our outcomes varied with age amongst those not exposed to the
38 intervention (people 16-40 in Blackpool and all people aged 5-40 in the comparison local authority)
39 for each deprivation quintile, using a local polynomial function. We then estimated a local
40 polynomial regression of our outcomes on age for the group exposed to the intervention – children
41 aged between 5 and 15 in Blackpool, for each deprivation quintile. The age specific effects of the
42 intervention were then calculated as the difference between the predicted values of the outcomes

1 for those exposed and the predicted value if they were not exposed, accounting for the average
2 difference in outcomes across all ages between Blackpool and the comparison local authority. We
3 additionally controlled for the average distance to the nearest swimming pool for each age group
4 and deprivation quintile within each local authority. Average treatment effects among all children
5 aged 5-15 were then calculated as the weighted average of these age specific differences based on
6 the population at each year of age (Full formulae are provided for the analysis in web Appendix 1).

7 The main assumption underlying this analysis is that in the absence of the intervention the outcomes
8 in Blackpool and the comparison local authority would vary by an approximately constant amount
9 across all ages – in other words the functional forms relating age to each outcome in the two local
10 authorities would be parallel. This is equivalent to the parallel trends assumptions of difference-in-
11 difference study designs.(18) We are assuming that there are unobserved factors that differ
12 between Blackpool and the comparison LA that affect participation across all age groups from 5 to
13 40, for example the ethnic composition of the population, levels of disability, neighbourhood
14 characteristics or the quality of local authority swimming facilities. By accounting for the average
15 difference in overall swimming participation levels between Blackpool and the comparison local
16 authority these unobserved factors are adjusted for in the analysis. We test whether this ‘parallel
17 trends assumption’ is reasonable in additional analysis in web appendix 2.

18 In a robustness test we also investigated whether there were spillover effects on age groups over 15.
19 These could occur, for example, where the intervention encouraged other older people to swim
20 more frequently, for example older friends, siblings or parents attending to accompany children
21 under 16. This was checked by setting the cut-off point at each age from 5 to 40 years old and
22 estimating the difference between the actual and expected outcomes at each age. (see web
23 appendix 2).

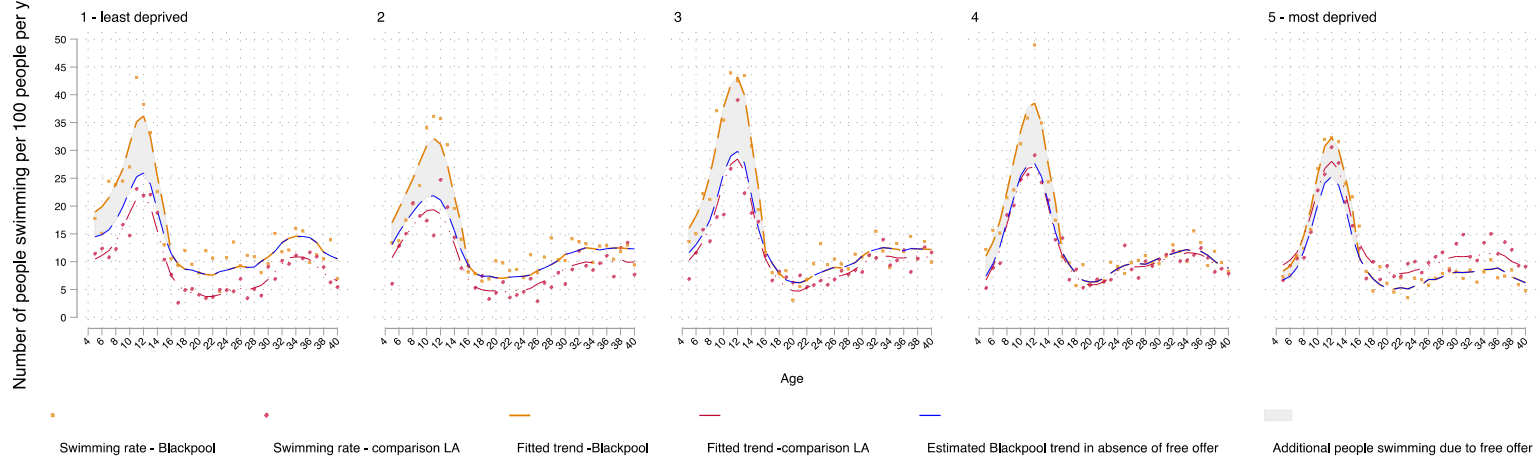
24 RESULTS

25 Figure 1 shows swimming attendance rate and the rate of people swimming in 2014 by single year of
26 age in Blackpool and the comparison local authority for each deprivation quintile and the fitted
27 values from the local polynomial regressions. The blue dashed line indicates the trend in Blackpool
28 that would be expected in the absence of the intervention. The grey area indicates the effect of the
29 intervention – the difference between the observed and expected levels.

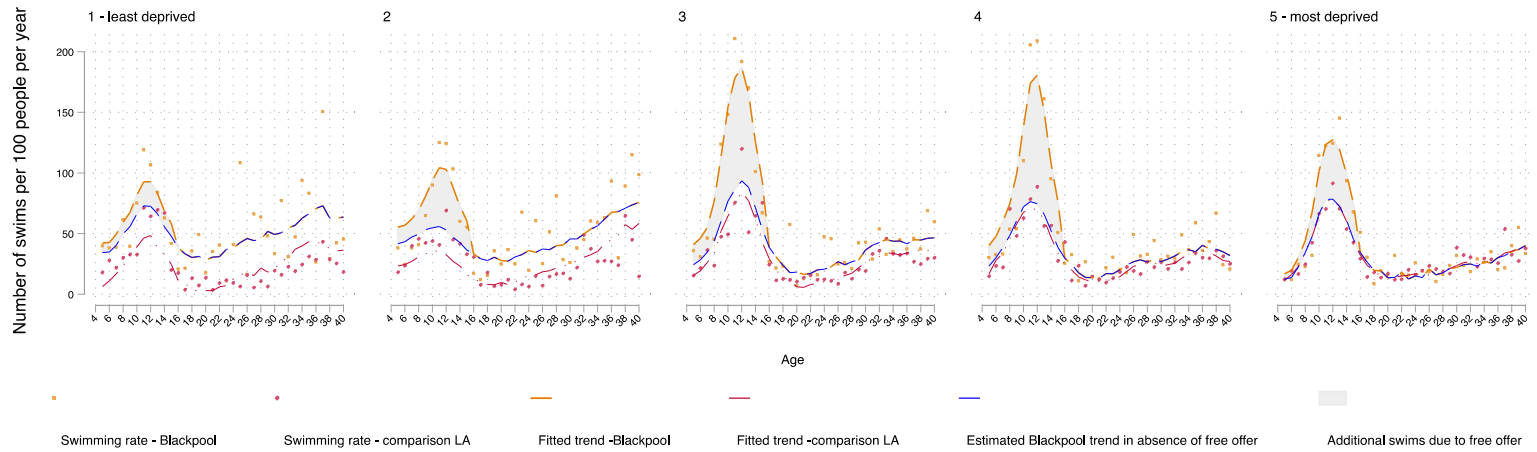
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31 **Figure 1. Swimming attendance rate and rate of people swimming (i.e. rate of unique swimmers)**
32 **by single year of age and deprivation quintile for 5-40 year olds, in Blackpool and in the**
33 **comparison local authority in 2014. Fitted lines derived from local polynomial regressions.**

1. Rate of people swimming



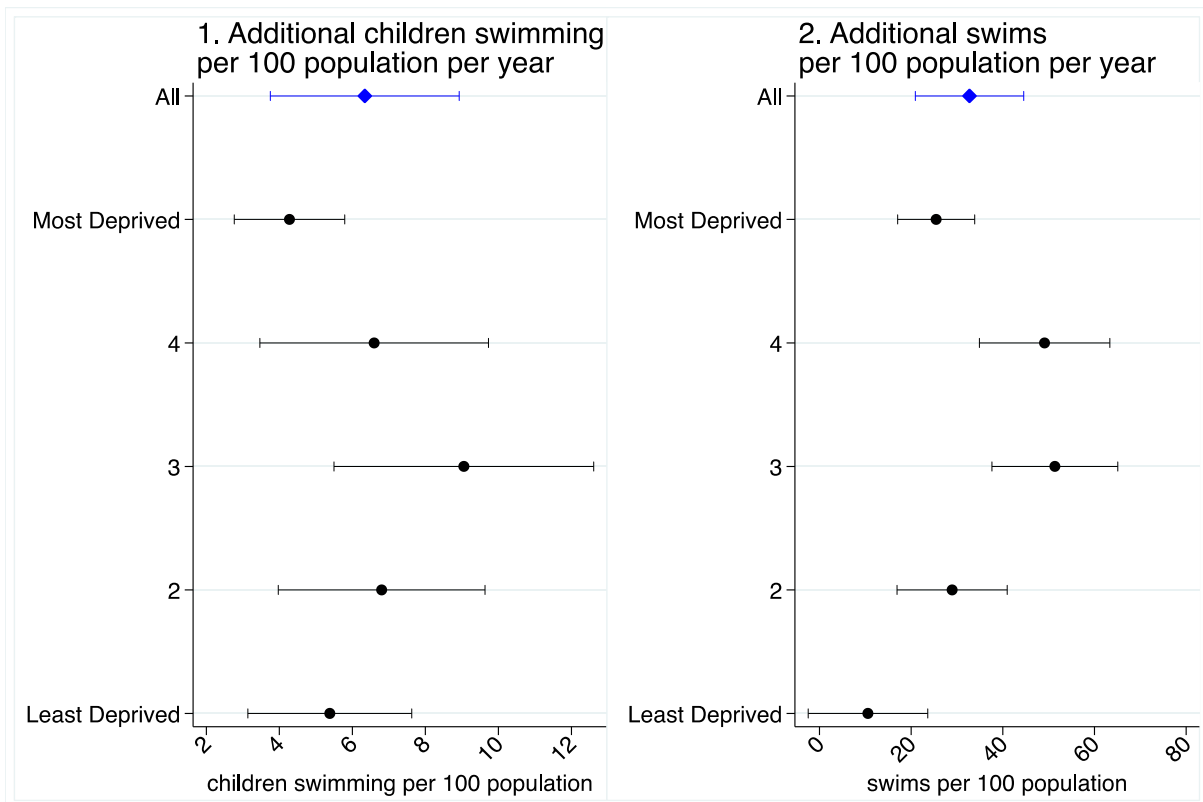
2. Swimming attendance rate



1 The rate of people swimming and the swimming attendance rate for those aged 16 and over was
 2 similar in Blackpool as in the comparison LA. Although the difference between the rates in Blackpool
 3 and the comparisons local authority varied between deprivation groups, within these groups the
 4 difference was approximately constant between the ages of 16 and 40 years old. We tested this
 5 formally in web appendix 2 and find that there is no significant deviation from the parallel trends
 6 assumption for these ages. The rates increase for children under the age of 16 in both local
 7 authorities, however this increase is greater in Blackpool than in the comparison local authority. The
 8 extent to which the rates in Blackpool were higher than the expected levels, was greatest in quintiles
 9 3-4.

10 **Figure 2. Estimated impact of the free swimming offer in Blackpool on the additional children**
 11 **swimming and the additional swims per 100 population.**

12



13

14 Figure 2 shows the estimates of the effect of the free-swimming offer from the comparative
 15 regression discontinuity model. Overall the free swimming offer was associated with an additional 6
 16 children swimming per 100 children per year (95% CI 4 to 9). There was no significant difference in
 17 this outcome across deprivation quintiles, although the effect was greatest in quintile 3. Overall the
 18 free-swimming offer was associated with an additional 33 swims per 100 population per year (95%
 19 CI 21 to 44). This rate was higher in quintiles 3 and 4, but lower in the most and least deprived areas
 20 of Blackpool. In terms of the number of additional swims the effect in the least deprived areas was
 21 not statistically significant at the 5% level.

1 Investigation of spillover effects across older age groups indicate that there was no evidence that the
2 intervention was increasing the swimming participation of people older than 16. The effects of the
3 intervention were greatest amongst children aged 10-14 years old.

4 **DISCUSSION**

5 **Main findings of this study**

6 We found that offering free-swimming during the school holidays to children living in a very
7 deprived local authority area was associated with an increase in participation in swimming. The
8 effect was greatest amongst children living in areas that were moderately deprived compared to the
9 rest of the borough, but was less pronounced in the least and most deprived parts of the borough.

10 **What is already known on this topic**

11 The evaluation of the national free swimming initiative in the UK estimated that it led to an
12 additional one swimmer and 44 swims per 100 children in the first year. This analysis was however
13 based on hypothetical questions in an online survey – asking people about what they would have
14 done in the absence of free swimming.(19) Such approaches are likely to have a high risk of bias and
15 may not reflect people’s actual behaviour change when entrance charges were removed. Studies
16 and reviews comparing swimming rates for children before and after the introduction of free offers
17 **have reported larges increases in participation, with a particular increase during school holidays(20–**
18 **22). However, these and other similar process evaluations provide limited evidence of the causal**
19 **effect of free swimming initiatives.(23,24).**

20 **What this study adds**

21 Our findings suggest that removing the cost of swimming for children is effective in a very deprived
22 local authority, leading to an additional 6% of children swimming. These estimates are greater than
23 those reported in the evaluation of the national free swimming programme (an additional 1% of
24 children swimming as a result of the free offer). There are a number of potential reasons for this
25 difference. As outlined above the estimates from the national programme evaluation may not reflect
26 the causal impact of introducing free swimming for children. Also the national programme
27 evaluation only looked at average effects across the country. We found smaller effects in the least
28 deprived areas in Blackpool. These areas have a level of deprivation that is equal to the average for
29 England. It is therefore plausible that the effect of free swimming is greater in a more deprived area
30 than the average effect of a free swimming offer across the whole country.

31 We found that the effect of free swimming was greatest amongst children living in parts of Blackpool
32 that were moderately deprived compared to the rest of the borough (quintiles 3 and 4), whilst
33 effects were smaller in the most deprived areas (quintile 5). Quintiles 3 and 4 in Blackpool are within
34 the bottom 25% most deprived areas in the country. Although the effects were smaller in quintile 5,
35 they still indicate that an additional 4% of children from these areas participated in swimming
36 because of the free-swimming offer. This in itself could be seen as a relatively large effect given that
37 the 20% most deprived neighbourhoods in Blackpool are extremely deprived – within the bottom 2%
38 of areas nationally. Many residents in these areas will experience multiple forms of deprivation - for
39 example 50% are living in poverty, 30% have a disability, 40% are living in poor housing and 55% of
40 the working age population are out of work. (12) Given the multiple issues surrounding some

1 families in these very deprived areas it is perhaps not surprising that the free swimming offer had a
2 smaller effect on participation in these areas. Whilst many interventions to promote physical
3 activity are less effective in more disadvantaged populations, (25) our study indicates that providing
4 children with free access to swimming facilities can increase swimming participation in deprived
5 areas.

6

7 **Strengths and imitations of this study**

8 Our study has a number of strengths. Firstly we were able to utilise a robust quasi-experimental
9 design that is likely to provide causal estimates of the effect of the intervention. Secondly by
10 extracting administrative data we obtained data on participation in swimming at local authority
11 facilities for the whole population in the two local authorities included in this study. We therefore
12 did not need to rely on survey data from a population sample, which would be affected by sampling
13 error and response bias. Thirdly by analysing the data by levels of area deprivation we were able to
14 investigate the differential effects of the intervention on different socioeconomic groups.

15 Our findings, however, need to be understood in the context of several limitations. Firstly, it is not
16 possible to determine whether the study outcomes reflect a clinically relevant increase in physical
17 activity. It is possible that the increased participation in swimming reflected displacement from
18 other physical activity. In other words, if the free swimming offer induced some children to switch
19 from other physical activity to swimming, this will have limited the impact of the intervention on
20 overall levels of physical activity. Conversely children who were encouraged to do more swimming
21 because of the free offer may have also been encouraged to take up other forms of physical activity.
22 The study outcomes would then have underestimated the overall effects on physical activity.
23 Secondly, administrative data can be subject to errors. Although in the two study local authorities
24 swipe cards are used to access the swimming pools it is likely that some access occurs without it
25 being recorded on the administrative system and details such as age may be incorrectly recorded. It
26 is likely however that these errors will be approximately random. Thirdly, we relied on an area-based
27 indicator of socioeconomic status, which may not necessarily reflect the socioeconomic status of
28 people living in these areas. As we are investigating the average effects across deprivation groups,
29 however, it is only necessary that the area based measures reflect average levels of socioeconomic
30 status within those areas. Nevertheless, bias could result if there was an interaction between
31 deprivation group and individual measures of socioeconomic status –although there are no reasons
32 to think this would be the case. Fourthly, as with any observational study it is possible that
33 unmeasured confounders could bias the results. In part this issue is addressed by the study design
34 which accounts for any unmeasured confounder which affects participation across all ages from 5 to
35 40 years old. Other unmeasured confounders could however still bias the results if they have a
36 different effect on children’s levels of swimming participation than on adult swimming participation
37 and were more common in Blackpool than the comparator area. There are however no obvious
38 factors that meet these conditions.

39 **Conclusion.**

40 Local authorities in the UK are facing severe cuts to their budgets. Since 2013, however, they have
41 been granted greater responsibilities for promoting public health and reducing health inequalities.

1 They are therefore having to make difficult decisions about the targeting of resources to those
2 interventions that are likely to have an impact. This study shows that providing free access to
3 swimming facilities to children living in a deprived local authority can increase swimming
4 participation and may help promote physical activity amongst children in these areas, helping to
5 reduce inequalities in child health.

6

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9 Council for their support in data collection and providing contextual information.

10 **Ethics**

11 Ethics approval was not required.

12

13

14

What is already known on this subject

Physical inactivity is a public health concern, with one in three children classed as obese by age 10. This rate is higher in children from deprived areas, and increasing physical activity in children from deprived backgrounds is a means of addressing these health inequalities. Many local authorities offer free access to swimming facilities for children, however the extent to which this increases participation is not known, nor whether effects differ according to the socioeconomic deprivation of the neighbourhoods in which children live.

What this study adds.

Using a robust quasi-experimental method we found that providing free access to swimming facilities in Blackpool for under 16's during school holidays increased participation in this very deprived local authority. The effect was greatest in areas with intermediate levels of deprivation (quintiles 3 and 4) within this deprived LA. The study indicates that providing free access to swimming facilities to children living in a deprived local authority can increase swimming participation and may help promote physical activity amongst children in these areas, helping to reduce inequalities in child health.

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8

9 **References**

- 10 1. Sheard S. Profit is a dirty word: the development of public baths and wash-houses in Britain
11 1847–1915. *Soc Hist Med*. 2000;13(1):63–86.
- 12 2. Robinson L. *Managing Public Sport and Leisure Services*. London ; New York: Routledge; 2003.
13 208 p.
- 14 3. HSCIC. *Statistics on Obesity, Physical Activity and Diet*. London: HSCIC; 2016.
- 15 4. Noonan RJ, Boddy LM, Knowles ZR, Fairclough SJ. Cross-sectional associations between high-
16 deprivation home and neighbourhood environments, and health-related variables among
17 Liverpool children. *BMJ Open*. 2016 Jan 1;6(1):e008693.
- 18 5. Griffiths LJ, Cortina-Borja M, Sera F, Poulidou T, Geraci M, Rich C, et al. How active are our
19 children? Findings from the Millennium Cohort Study. *BMJ Open*. 2013 Jul 1;3(8):e002893.
- 20 6. Drenowatz C, Eisenmann JC, Pfeiffer KA, Welk G, Heelan K, Gentile D, et al. Influence of socio-
21 economic status on habitual physical activity and sedentary behavior in 8- to 11-year old
22 children. *BMC Public Health*. 2010 Apr 27;10:214.
- 23 7. Wijtzes AI, Jansen W, Bouthoorn SH, Pot N, Hofman A, Jaddoe VWV, et al. Social inequalities in
24 young children’s sports participation and outdoor play. *Int J Behav Nutr Phys Act* [Internet].
25 2014 Dec 16 [cited 2018 Feb 13];11. Available from:
26 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4272790/>
- 27 8. Department for Communities and Local Government. *Local authority revenue expenditure and
28 financing - Department for Communities and Local Government - GOV.UK* [Internet]. [cited
29 2013 Sep 12]. Available from: <https://www.gov.uk/government/organisations/departments-for-communities-and-local-government/series/local-authority-revenue-expenditure-and-financing>
- 30
- 31 9. Finnigan S, Bailey R. *Sports & Leisure: Trend analysis 2014/15*. Salford: APSE; 2015.
- 32 10. *Free Swimming Programme announcement - News stories - GOV.UK* [Internet]. [cited 2017 Feb
33 14]. Available from: <https://www.gov.uk/government/news/free-swimming-programme-announcement>
- 34
- 35 11. Audrey S, Wheeler BW, Mills J, Ben-Shlomo Y. Health promotion and the social gradient: The
36 free swimming initiative for children and young people in Bristol. *Public Health*. 2012
37 Nov;126(11):976–81.

- 1 12. Department for Communities and Local Government. The English Indices of Deprivation 2010
2 [Internet]. 2011 [cited 2012 Jan 17]. Available from:
3 <http://www.communities.gov.uk/publications/corporate/statistics/indices2010>
- 4 13. Shadish WR, Galindo R, Wong VC, Steiner PM, Cook TD. A randomized experiment comparing
5 random and cutoff-based assignment. *Psychol Methods*. 2011 Jun;16(2):179–91.
- 6 14. Cook TD, Shadish WR, Wong VC. Three conditions under which experiments and observational
7 studies produce comparable causal estimates: New findings from within-study comparisons. *J*
8 *Policy Anal Manage*. 2008 Sep 1;27(4):724–50.
- 9 15. Boon MH, Craig P, Moore L, Thomson H. OP69 Regression discontinuity designs in the
10 evaluation of health interventions, policies, and outcomes: a systematic review. *J Epidemiol*
11 *Community Health*. 2016 Sep 1;70(Suppl 1):A39–A39.
- 12 16. Shadish WR, Cook TD, Campbell DT. *Experimental and quasi-experimental designs for*
13 *generalized causal inference*. Houghton Mifflin; 2002. 666 p.
- 14 17. Wing C, Cook TD. Strengthening the Regression Discontinuity Design Using Additional Design
15 Elements: A Within-Study Comparison. *J Policy Anal Manage*. 2013 Sep 1;32(4):853–77.
- 16 18. Angrist JD, Pischke J-S. *Mostly Harmless Econometrics: An Empiricist’s Companion*. Princeton:
17 Princeton University Press; 2009. 392 p.
- 18 19. PricewaterhouseCoopers LLP. *Evaluation of the Impact of Free Swimming*. London:
19 PricewaterhouseCoopers LLP; 2010.
- 20 20. Coalter F. Entrance charges and sports participation: A review of evidence [Internet]. 2002
21 [cited 2014 May 7]. Available from:
22 [http://www.sportdevelopment.info/index.php/subjects/55-researchsurveys/132-entrance-](http://www.sportdevelopment.info/index.php/subjects/55-researchsurveys/132-entrance-charges-and-sports-participation-a-review-of-evidence)
23 [charges-and-sports-participation-a-review-of-evidence](http://www.sportdevelopment.info/index.php/subjects/55-researchsurveys/132-entrance-charges-and-sports-participation-a-review-of-evidence)
- 24 21. Coalter F. Free swimming – A need for a more strategic approach - Physical Activity Health
25 Alliance [Internet]. 2006 [cited 2014 May 7]. Available from:
26 [http://www.paha.org.uk/Resource/free-swimming-a-need-for-a-more-strategic-](http://www.paha.org.uk/Resource/free-swimming-a-need-for-a-more-strategic-approach#viewComments)
27 [approach#viewComments](http://www.paha.org.uk/Resource/free-swimming-a-need-for-a-more-strategic-approach#viewComments)
- 28 22. Bolton N, Martin S, Anderson M, Smith B, Jennings C. *Free Swimming: An Evaluation of the*
29 *Welsh Assembly Government’s Initiative* [Internet]. Sports Council for Wales; 2008 [cited 2017
30 Jan 30]. Available from: <https://repository.cardiffmet.ac.uk/handle/10369/583>
- 31 23. Bullough S, Davies LE, Barrett D. The impact of a community free swimming programme for
32 young people (under 19) in England. *Sport Manag Rev*. 2015 Feb;18(1):32–44.
- 33 24. Verhoef TI, Trend V, Kelly B, Robinson N, Fox P, Morris S. Cost-effectiveness analysis of offering
34 free leisure centre memberships to physically inactive members of the public receiving state
35 benefits: a case study. *BMC Public Health* [Internet]. 2016 Dec [cited 2016 Oct 14];16(1).
36 Available from: [http://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-016-](http://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-016-3300-x)
37 [3300-x](http://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-016-3300-x)
- 38 25. Beauchamp A, Backholer K, Magliano D, Peeters A. The effect of obesity prevention
39 interventions according to socioeconomic position: a systematic review. *Obes Rev Off J Int*
40 *Assoc Study Obes*. 2014 Jul;15(7):541–54.

