# Association between Magnetic Resonance Image (MRI) Assessed Abdominal Adiposity, Objectively Measured Physical Activity (PA) in ALSPAC Cohort Children age 11-13y

Benfield LL,[1] Fox KR,[2] Peters DM,[3] , Ness A,[4] Lawlor DA[1]

[1] MRC Centre for Causal Analysis in Translational Epidemiology, Department of Social Medicine, University of Bristol, UK; [2]Department of Exercise, Nutrition and Health Sciences, University of Bristol, UK; [3]Institute of Sport &Exercise Science, University of Worcester, UK; Faculty of Health & Sport, University of Agder, Norway; [4]Department of Oral and Dental Science,University of Bristol, UK

# Backgrounds

- ALSPAC:
  - Enrolled pregnancies 14,541
  - Of these 13,988 live born infants who survived to at least 1 year
  - Being followed, 13,971 children and 13,801 mothers

- Abdominal adiposity and Physical activity
  - Abdominal fatness and patterns, health risk
  - Physical activity (PA) measure matters (Rowlands et al., 2000)
  - Limited data with accurate measures

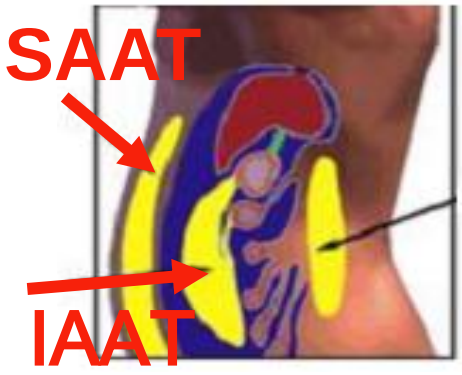
# Aims

- Preliminary assessment of the association between parameters of physical activity (as assessed by accelerometer) and MRI-assessed abdominal adiposity in a sub-sample of ALSPAC (170 children age 11-13y)
- Apply MRI-determined abdominal adiposity prediction equation to derive predicted-abdominal adiposity variables in order to assess the association between abdominal adiposity and physical activity for the whole cohort British children (mean age at 12 years)
- Investigate if this association are stronger compared with simple measures of BMI and DXA for the whole cohort British children (mean age at 12 years)

# Methods

- Define PA variables (Ness, Leary et al. 2007):
  - **TPA:** Total physical activity (accelerometer counts per minute) based on a minimum of 3 valid days over a whole week
  - **MVPA**: Moderate and vigorous activity was based on accelerometer cut-points of 3600, 6200 counts/minute on valid days (>= 3 days) over whole week
  - **Light PA**: Physical activity based on cut-points between 200 and 3600 counts/minute on valid days (>= 3 days) over whole week
  - **Sedentary level**: Defined as less than 199 counts/minute based on valid days (>= 3 days) over whole week
- Age, puberty status and anthropometry
- DXA measures of whole body composition
- Sub-sample 170 children (74 boys and 96 girls) undertook a sequence of truncal MRI scans

- Intra-abdominal adipose tissue (IAAT)
  Subcutaneous abdominal adipose tissue(SAAT)

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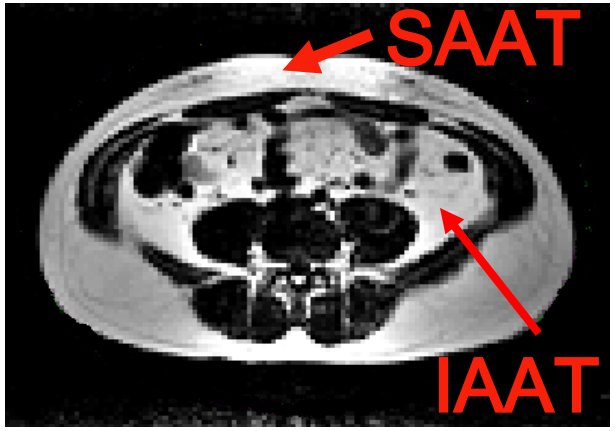


Abdominal MRI image (Level L4-L5)

# Table1: Characteristics of subjects in sub-sample of 170 children (Mean ± SD)

| Sex | Boys (96) | Girls (74) | P |
|---|---|---|---|
| Age (y) | 13.4 ± 0.4 | 13.5 ± 0.5 | p=0.937 |
| Sexual maturity<br>(Pre/Early/Late) | 61 boys<br>(27/30/4) | 52 girls<br>(1/38/13) | p<0.001 |
| IAAT ($cm^3$) | 117.2± 114.1 | 154.2± 111.7 | p=0.036 |
| SAAT ($cm^3$) | 1116.5± 1018.0 | 1569.2± 937.4 | p=0.003 |
| IAAT/SAAT ratio | 0.13± 0.06 | 0.10± 0.04 | p=0.002 |

# Key findings from preliminary analysis in sub-sample of 170 children

- Two different but complementary measures of gross movement (accelerometer counts) and time spent immobile (sedentary time) produced consistent patterns of association indicating that abdominally fatter girls are more likely to be less active. Conversely, there seems to be no effect for physical activity on the abdominal fatness for boys based on this sub-sample .
- The time spent in sedentary could be more crucial than moderate-vigorous PA or light PA for the development and the maintenance of abdominal adiposity (at least in girls).

# Prediction of MRI-measured abdominal adiposity parameters

- Prediction models for MRI-derived abdominal adiposity using DXA and anthropometry based on one randomly selected sub-sample (91children: 48boys and 43girls)
- Cross-validation of prediction equations based on the other randomly selected sub-sample (67children: 42boys and 25girls)
- Validation statistics:
  - Good stability of R-squared for IAAT
  - The pure errors of IAAT in the second sub-sample were similar to the standard error of estimate in the first sub-sample
  - Using the second sub-sample, pair t-test showed no evidence of bias between the mean differences (MRI-measured and predicted values)
  - MRI-measured and predicted values was highly correlated (r=0.88)

# Predicted intra-abdominal adiposity parameters for ALSPAC cohort

- Using the prediction equation to generate predicted intra-abdominal adiposity variable for all children, also for boys and girls (as sex interaction shown, P<0.0005)

- Validation statistics:
  - Good stability of R-squared for IAAT
  - The pure errors of IAAT in the whole cohort sample were similar to the standard error of estimate in sub-sample where equation was developed from
  - MRI-measured (in sub-sample) and predicted values (in cohort) was highly correlated (r=0.82)

# Children in the ALSPAC cohort

- A total of 11,952 children were invited to attend the research 11-year clinic
- Of these, 7,159 (59.9%) came to the clinic, and 6,622 (92.5%) agreed to wear an Actigraph
- Estimates of intra-abdominal adiposity variable base on prediction equation were available on 5,834 children with valid physical activity measures.
- Average age =141 months, referred to mean age as 12-year-old (age range 11 to 13y)

# The Association between Objectively Measured Total Physical Activity and Body Composition SD Scores in 5,500 11-Year-Old Children from ALSPAC

| Group | *n* | Model[a] | BMI | | | Fat Mass | | | Lean Mass | | | Trunk Fat | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | β[b] | 95% CI | *p*-Value | β[b] | 95% CI | *p*-Value | β[b] | 95% CI | *p*-Value | β[b] | 95% CI | *p*-Value |
| **Boys** | 2,617 | 1 | −0.09 | −0.11 to −0.07 | <0.001 | −0.11 | −0.13 to −0.10 | <0.001 | 0.03 | 0.01 to 0.04 | <0.001 | −0.11 | −0.13 to −0.09 | <0.001 |
| | 1,960 | 2 | −0.09 | −0.11 to −0.07 | <0.001 | −0.12 | −0.14 to −0.10 | <0.001 | 0.02 | 0.01 to 0.03 | 0.001 | −0.11 | −0.13 to −0.09 | <0.001 |
| | 1,719 | 3 | −0.09 | −0.11 to −0.07 | <0.001 | −0.13 | −0.15 to −0.10 | <0.001 | 0.02 | 0.01 to 0.03 | 0.004 | −0.12 | −0.14 to −0.09 | <0.001 |
| | 882 | 4 | −0.10 | −0.13 to −0.07 | <0.001 | −0.14 | −0.17 to −0.11 | <0.001 | 0.02 | 0.00 to 0.04 | 0.029 | −0.13 | −0.16 to −0.10 | <0.001 |
| **Girls** | 2,874 | 1 | −0.06 | −0.08 to −0.03 | <0.001 | −0.08 | −0.10 to −0.06 | <0.001 | 0.04 | 0.03 to 0.06 | <0.001 | −0.08 | −0.10 to −0.06 | <0.001 |
| | 2,183 | 2 | −0.06 | −0.09 to −0.04 | <0.001 | −0.08 | −0.10 to −0.05 | <0.001 | 0.04 | 0.02 to 0.05 | <0.001 | −0.07 | −0.10 to −0.05 | <0.001 |
| | 1,887 | 3 | −0.06 | −0.09 to −0.03 | <0.001 | −0.07 | −0.09 to −0.05 | <0.001 | 0.04 | 0.02 to 0.05 | <0.001 | −0.07 | −0.09 to −0.04 | <0.001 |
| | 1,327 | 4 | −0.02 | −0.06 to 0.01 | 0.179 | −0.06 | −0.09 to −0.03 | <0.001 | 0.05 | 0.03 to 0.07 | <0.001 | −0.06 | −0.08 to −0.03 | <0.001 |

[a]Model 1 = age, height, and height squared; Model 2 = model 1 + social factors (i.e., maternal education, lowest social class, birthweight, gestational age, smoking in pregnancy, obesity of mother in pregnancy); Model 3 = model 2 + other factors (i.e., sleep pattern and TV viewing); Model 4 = model 3 + puberty at 12.

[b]β gives the regression coefficient of the SD score per 100 cpm. The SDs of the outcome variables were: log (BMI) = 0.17; log (fat mass) = 0.57; lean mass = 4.40; log (trunk fat) = 0.66.

doi:10.1371/journal.pmed.0040097.t003

Ness, A. R., S. D. Leary, et al. (2007). "Objectively measured physical activity and fat mass in a large cohort of children." PLoS Med **4**: e97.

# Table2: The Association between Objectively Measured Total Physical Activity and predicted intra-abdominal adiposity SD Scores in 5,834 12-Year-Old Children from ALSPAC

| Group | N | Model* | ß | 95% CI | P-value |
|---|---|---|---|---|---|
| Boys | 2762 | 1 | -0.07 | -0.09 to -0.06 | <0.001 |
| | 2034 | 2 | -0.07 | -0.09 to -0.05 | <0.001 |
| | 1835 | 3 | -0.07 | -0.09 to -0.06 | <0.001 |
| | 1835 | 4 | -0.07 | -0.09 to -0.06 | <0.001 |
| Girls | 2278 | 1 | -0.03 | -0.06 to -0.01 | <0.001 |
| | 1774 | 2 | -0.02 | -0.05 to -0.00002 | <0.001 |
| | 1641 | 3 | -0.02 | -0.05 to -0.003 | <0.001 |
| | 1641 | 4 | -0.02 | -0.04 to 0.009 | <0.001 |

Model1=age, height, height squared; Model2=Model 1+social factors(i.e. Maternal education, lowest social class, birthweight, gestational age,smoking in pregancy, obesity of mother in pregnancy); Model3=Model2+other factors(i.e. sleep pattern and TV viewing); Model4=Model3+ puberty at 12

# The Association between Objectively Measured Minutes of MVPA and Body Composition SD Scores in 5,500 12-Year-Old Children from ALSPAC

| Group | *n* | Model | BMI | | | Fat Mass | | | Lean mass | | | Trunk fat | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | β[b] | 95% CI | *p*-Value | β[b] | 95% CI | *p*-Value | β[b] | 95% CI | *p*-Value | β[b] | 95% CI | *p*-Value |
| Boys | 2,617 | 1 | −0.17 | −0.20 to −0.14 | <0.001 | −0.23 | −0.26 to −0.20 | <0.001 | 0.03 | 0.01 to 0.04 | 0.003 | −0.22 | −0.25 to −0.19 | <0.001 |
| | 1,960 | 2 | −0.17 | −0.21 to −0.14 | <0.001 | −0.23 | −0.27 to −0.20 | <0.001 | 0.02 | 0.00 to 0.04 | 0.101 | −0.22 | −0.25 to −0.19 | <0.001 |
| | 1,719 | 3 | −0.17 | −0.21 to −0.14 | <0.001 | −0.24 | −0.27 to −0.20 | <0.001 | 0.02 | −0.01 to 0.04 | 0.146 | −0.22 | −0.26 to −0.19 | <0.001 |
| | 882 | 4 | −0.18 | −0.23 to −0.13 | <0.001 | −0.25 | −0.30 to −0.20 | <0.001 | 0.01 | −0.02 to 0.04 | 0.509 | −0.24 | −0.29 to −0.19 | <0.001 |
| Girls | 2,874 | 1 | −0.13 | −0.18 to −0.08 | <0.001 | −0.17 | −0.21 to −0.13 | <0.001 | 0.04 | 0.02 to 0.07 | 0.001 | −0.17 | −0.21 to −0.13 | <0.001 |
| | 2,183 | 2 | −0.13 | −0.18 to −0.08 | <0.001 | −0.16 | −0.20 to −0.12 | <0.001 | 0.04 | 0.01 to 0.07 | 0.006 | −0.16 | −0.21 to −0.12 | <0.001 |
| | 1,887 | 3 | −0.12 | −0.18 to −0.07 | <0.001 | −0.15 | −0.20 to −0.11 | <0.001 | 0.04 | 0.01 to 0.07 | 0.016 | −0.16 | −0.20 to −0.11 | <0.001 |
| | 1,327 | 4 | −0.10 | −0.17 to −0.04 | 0.002 | −0.15 | −0.21 to −0.10 | <0.001 | 0.05 | 0.02 to 0.09 | 0.004 | −0.15 | −0.21 to −0.10 | <0.001 |

[a]Model 1 = age, height, and height squared; Model 2 = model 1 + social factors (i.e., maternal education, lowest social class, birthweight, gestational age, smoking in pregnancy, obesity of mother in pregnancy); Model 3 = model 2 + other factors (i.e., sleep pattern and TV viewing); Model 4 = model 3 + puberty at 12.
[b]β gives the regression coefficient of the SD score per 15 minutes of MVPA. The SD of the outcome variables were: log (BMI) = 0.17; log (fat mass) = 0.57; lean mass = 4.40; log (trunk fat) = 0.66.
doi:10.1371/journal.pmed.0040097.t004

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# Table3: The Association between Objectively Measured Minutes of MVPA and predicted intra-abdominal adiposity SD Scores in 5,834 12-Year-Old Children from ALSPAC

| Group | N | Model* | ß | 95% CI | P-value |
|---|---|---|---|---|---|
| Boys | 2762 | 1 | -0.28 | -0.32 to -0.23 | <0.001 |
| | 2034 | 2 | -0.24 | -0.28 to -0.19 | <0.001 |
| | 1835 | 3 | -0.24 | -0.29 to -0.19 | <0.001 |
| | 1835 | 4 | -0.24 | -0.29 to -0.19 | <0.001 |
| Girls | 2278 | 1 | -0.15 | -0.21 to -0.10 | <0.001 |
| | 1774 | 2 | -0.09 | -0.14 to -0.04 | <0.001 |
| | 1641 | 3 | -0.10 | -0.15 to -0.03 | <0.001 |
| | 1641 | 4 | -0.08 | -0.14 to -0.03 | <0.001 |

Model1=age, height, height squared; Model2=Model 1+social factors(i.e. Maternal education, lowest social class, birthweight, gestational age,smoking in pregancy, obesity of mother in pregnancy); Model3=Model2+other factors(i.e. sleep pattern and TV viewing); Model4=Model3+ puberty at 12

- In Table 2, ß gives the regression coefficient of the score per 100 cpm (total physical activity), the SDs of the outcome variables:
  - Log (IAAT)=0.70
  - Log (BMI)=0.17
  - Log (DXA-trunk fat mass)=0.66
  - Log (DXA-total fat mass)=0.57
  - DXA-Lean mass =4.40
- IN Table 3, ß gives the regression coefficient of the score per 15mins of MVPA (moderate and vigorous activity), the SDs of the outcome variables:
  - Log (IAAT)=0.70
  - Log (BMI)=0.17
  - Log (DXA-trunk fat mass)=0.66
  - Log (DXA-total fat mass)=0.57
  - DXA-Lean mass =4.40

# Key findings in ALSPAC cohort

- A strong negative dose-response association observed between objectively measured physical activity and intra-abdominal fatness.
- A similar pattern observed which the association between both physical activity variables and intra-abdominal fatness was stronger in boys than girls.
- The associations between moderate and vigorous physical activity and intra-abdominal fatness were stronger to those observed for trunk fat and total fat mass. And they are much stronger than those observed for BMI.
- The associations between MVPA and intra-abdominal fatness were unaltered after adjustment for total physical activity, but the associations between total physical activity and intra-abdominal fatness disappeared when adjusted for MVPA.

# Conclusions and Implication

- Our data provide the support for the physical activity recommendations for children that are framed in terms of MVPA rather than total physical activity
- Our results suggest that though higher levels of physical activity are associated with reduced risk of abdominal obesity in both boys and girls, the strength of the association between physical activity level and abdominal obesity differs between boys and girls. This may be because:
  - Physical activity has a stronger effect on subcutaneous abdominal fat than intra-abdominal fat at this age.
  - Girls simply are less active (physical activity levels were higher in boys than girls, 663 versus 605 cpm, $p < 0.001$).

University of BRISTOL

# Thank You!

Li Benfield (Li.Benfield@bristol.ac.uk)

MRC Centre for Causal Analyses in Translational Epidemiology