# Spending at least 120 minutes a week in nature is associated with good health and wellbeing

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## Appendix A: Response distributions of the health and wellbeing outcomes

*Figure A*: Histogram of self-reported health.

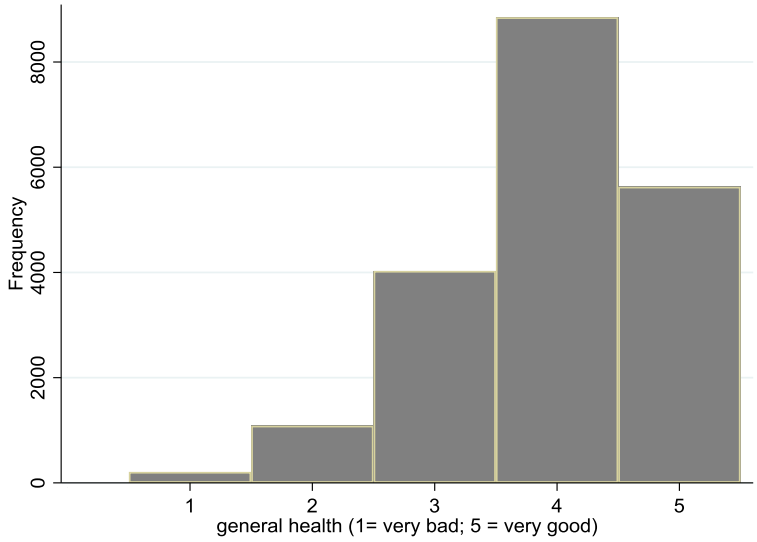



*Figure B*: Histogram of life satisfaction

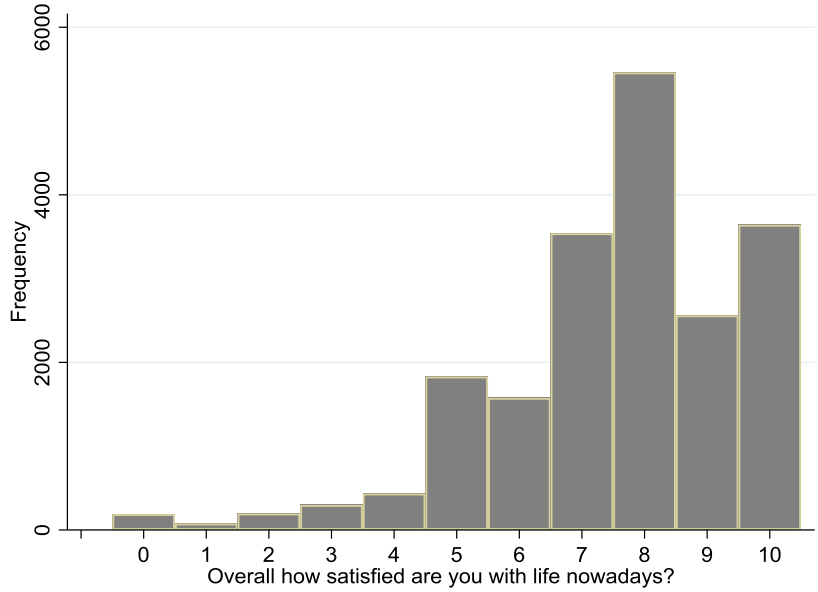
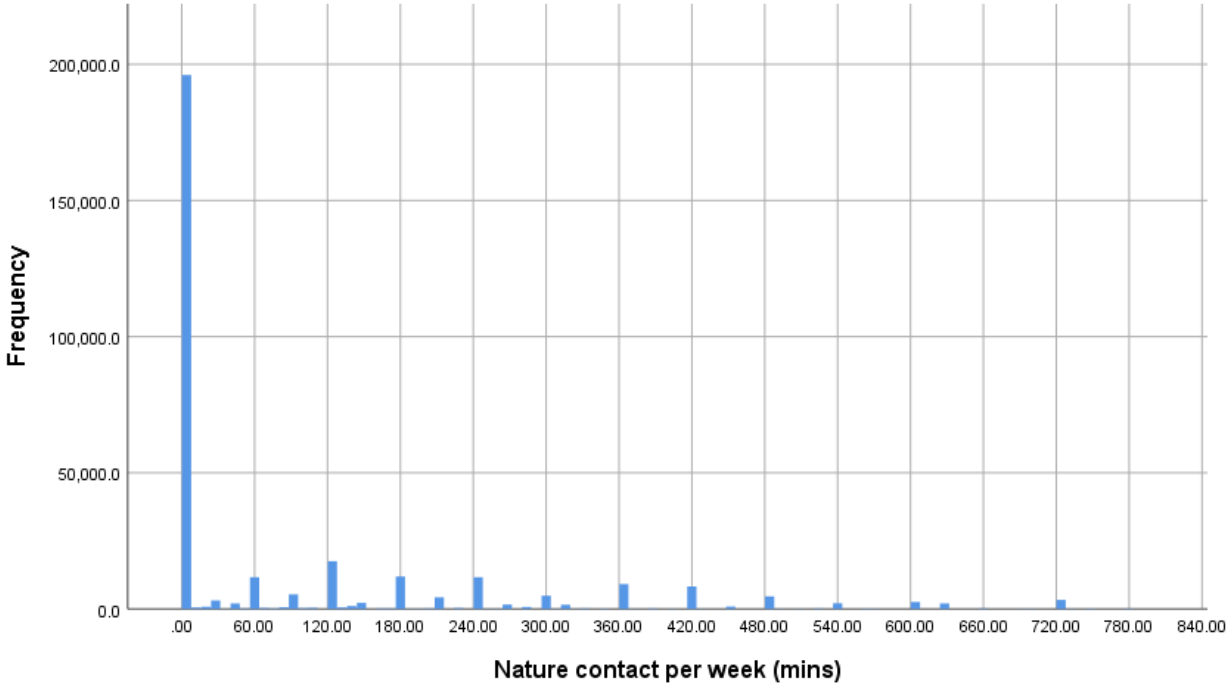


*Figure C*: Histogram of recreational contact with nature per week (in minutes)




*N.B. Duration capped at 800 minutes for ease of viewing. The clustering of responses around the hour marks (60, 120, 180, 240, 300, 360, 420 minutes etc.) is clearly visible.*

**Appendix B: The frequency and percent of respondents in each category of each predictor who reported good/very good health and high well-being.**

*Supplementary Table S1:* The frequency and percent of respondents in each category of each predictor who reported good/very good health and high well-being.

| | Self-reported health | | | | | | | Subjective well-being | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Raw Ns and %s | | | | | (Weighted %s) | | Raw Ns and %s | | | | | (Weighted %s) | |
| | Not good | | Good | | | Not good | Good | | Low | | High | | Low | High |
| | N | % | N | % | Total N | % | % | N | % | N | % | Total N | % | % |
| **Nature visit exposure** | | | | | | | | | | | | | | |
| Weekly visit duration | | | | | | | | | | | | | | |
| ≥300 mins | 700 | 20.1 | 2784 | 79.9 | *3484* | (18.1 | 81.9) | 1228 | 35.2 | 2256 | 64.8 | *3484* | (34.5 | 65.5) |
| 240-299 mins | 159 | 18.0 | 723 | 82.0 | *882* | (15.5 | 84.5) | 309 | 35.0 | 537 | 65.0 | *882* | (34.1 | 65.9) |
| 180-239 mins | 207 | 20.4 | 807 | 79.6 | *1014* | (18.1 | 81.9) | 374 | 36.9 | 640 | 63.1 | *1014* | (36.0 | 64.0) |
| 120-179 mins | 232 | 18.0 | 1058 | 82.0 | *1290* | (15.5 | 84.5) | 465 | 36.0 | 825 | 64.0 | *1290* | (35.3 | 64.7) |
| 60-119 mins | 253 | 22.7 | 860 | 77.3 | *1113* | (19.7 | 80.3) | 439 | 39.4 | 674 | 60.6 | *1113* | (38.2 | 61.8) |
| 1-59 mins | 97 | 27.3 | 258 | 72.7 | *355* | (25.2 | 74.8) | 155 | 43.7 | 200 | 56.3 | *355* | (41.7 | 58.3) |
| 0 mins | 3678 | 31.5 | 7990 | 68.5 | *11668* | (27.7 | 72.3) | 5173 | 44.3 | 6495 | 55.7 | *11668* | (42.8 | 57.2) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.8* | *60.2*) |
| **Area level covariates** | | | | | | | | | | | | | | |
| *Urbanicity* | | | | | | | | | | | | | | |
| Rural | 285 | 25.6 | 827 | 74.4 | *1112* | (22.4 | 77.6) | 365 | 32.8 | 747 | 67.2 | *1112* | (32.0 | 68.0) |
| Urban/town fringe | 5041 | 27.0 | 13653 | 73.0 | *18694* | (23.5 | 76.5) | 7778 | 41.6 | 10916 | 58.4 | *18694* | (40.2 | 59.8) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| Neighbourhood green | | | | | | | | | | | | | | |
| Greenest quintile | 1054 | 26.6 | 2909 | 73.4 | *3963* | (23.0 | 77.0) | 1386 | 35.0 | 2577 | 65.0 | *3963* | (33.6 | 66.4) |
| Quintile 2 | 1056 | 26.6 | 2910 | 73.4 | *3966* | (23.6 | 76.4) | 1616 | 40.7 | 2350 | 59.3 | *3966* | (39.4 | 60.6) |
| Quintile 3 | 1165 | 29.4 | 2792 | 70.6 | *3957* | (25.4 | 74.6) | 1688 | 42.7 | 2269 | 57.3 | *3957* | (40.5 | 59.5) |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quintile 4 | 1074 | 27.2 | 2880 | 72.8 | *3954* | (23.7 | 76.3) | 1662 | 42.0 | 2292 | 58.0 | *3954* | (41.2 | 58.8) |
| Least green quintile | 977 | 24.6 | 2989 | 75.4 | *3966* | (21.6 | 78.4) | 1791 | 45.2 | 2175 | 54.8 | *3966* | (44.1 | 55.9) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| Area Deprivation | | | | | | | | | | | | | | |
| Least deprived quintile | 855 | 21.2 | 3182 | 78.8 | *4037* | (19.2 | 80.8) | 1375 | 34.1 | 2662 | 65.9 | *4037* | (33.3 | 66.7) |
| Quintile 2 | 894 | 24.1 | 2810 | 75.9 | *3704* | (21.0 | 79.0) | 1392 | 37.6 | 2312 | 62.4 | *3704* | (36.6 | 63.4) |
| Quintile 3 | 1007 | 26.9 | 2730 | 73.1 | *3737* | (24.1 | 75.9) | 1486 | 39.8 | 2251 | 60.2 | *3737* | (38.7 | 61.3) |
| Quintile 4 | 1155 | 28.5 | 2902 | 71.5 | *4057* | (24.6 | 75.4) | 1815 | 44.7 | 2242 | 55.3 | *4057* | (43.6 | 56.4) |
| Most deprived quintile | 1415 | 33.1 | 2856 | 66.9 | *4271* | (29.3 | 70.7) | 2075 | 48.6 | 2196 | 51.4 | *4271* | (47.4 | 52.6) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| Air pollution | | | | | | | | | | | | | | |
| $PM_{10}$ lowest tertile | 1930 | 29.2 | 4685 | 70.8 | *6615* | (25.4 | 74.6) | 2569 | 38.8 | 4046 | 61.2 | *6615* | (37.3 | 62.7) |
| $PM_{10}$ middle tertile | 1784 | 27.0 | 4832 | 73.0 | *6616* | (23.5 | 76.5) | 2682 | 40.5 | 3934 | 59.5 | *6616* | (39.1 | 60.9) |
| $PM_{10}$ highest tertile | 1612 | 24.5 | 4963 | 75.5 | *6575* | (21.5 | 78.5) | 2892 | 44.0 | 3683 | 56.0 | *6575* | (42.7 | 57.3) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| **Individual covariates** | | | | | | | | | | | | | | |
| Sex | | | | | | | | | | | | | | |
| Male | 2528 | 26.9 | 6859 | 73.1 | *9387* | (22.8 | 77.2) | 3955 | 42.1 | 5432 | 57.9 | *9387* | (41.0 | 59.0) |
| Female | 2798 | 26.9 | 7621 | 73.1 | *10419* | (24.1 | 75.9) | 4188 | 40.2 | 6231 | 59.8 | *10419* | (38.4 | 61.6) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| Age | | | | | | | | | | | | | | |
| 16-64 years | 3223 | 22.0 | 11444 | 78.0 | *14667* | (19.2 | 80.8) | 6273 | 42.8 | 8394 | 57.2 | *14667* | (41.0 | 59.0) |
| ≥ 65 years | 2103 | 40.9 | 3036 | 59.1 | *5139* | (38.7 | 61.3) | 1870 | 36.4 | 3269 | 63.6 | *5139* | (35.1 | 64.9) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| Socio-economic status | | | | | | | | | | | | | | |
| AB (Highest) | 637 | 18.3 | 2835 | 81.7 | *3472* | (17.8 | 82.2) | 1131 | 32.6 | 2341 | 67.4 | *3472* | (32.8 | 67.2) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C1 | 1016 | 19.7 | 4136 | 80.3 | *5152* | (19.3 | 80.7) | 1962 | 38.1 | 3190 | 61.9 | *5152* | (38.3 | 61.7) |
| C2 | 905 | 22.7 | 3088 | 77.3 | *3993* | (21.9 | 78.1) | 1599 | 40.0 | 2394 | 60.0 | *3993* | (40.6 | 59.4) |
| DE (Lowest) | 2768 | 38.5 | 4421 | 61.5 | *7189* | (35.5 | 64.5) | 3451 | 48.0 | 3738 | 52.0 | *7189* | (47.5 | 52.5) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| Restricted functioning | | | | | | | | | | | | | | |
| No | 2112 | 13.8 | 13149 | 86.2 | *15261* | (12.6 | 87.4) | 5685 | 37.3 | 9576 | 62.7 | *15261* | (36.7 | 63.3) |
| Yes | 3214 | 70.7 | 1331 | 29.3 | *4545* | (68.2 | 31.8) | 2458 | 54.1 | 2087 | 45.9 | *4545* | (52.0 | 48.0) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| Physically active | | | | | | | | | | | | | | |
| No (< 150 mins pw) | 4376 | 29.2 | 10632 | 70.8 | *15008* | (25.5 | 74.5) | 6340 | 42.2 | 8668 | 57.8 | *15008* | (40.8 | 59.2) |
| Yes (≥ 150 mins pw) | 950 | 19.8 | 3848 | 80.2 | *4798* | (17.4 | 82.6) | 1803 | 37.6 | 2995 | 62.4 | *4798* | (36.1 | 63.9) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| Employed full-time | | | | | | | | | | | | | | |
| No | 4355 | 33.4 | 8685 | 66.6 | *13040* | (30.9 | 69.1) | 5444 | 41.7 | 7596 | 58.3 | *13040* | (39.8 | 60.2) |
| Yes | 971 | 14.4 | 5795 | 85.6 | *6766* | (14.2 | 85.8) | 2699 | 39.9 | 4067 | 60.1 | *6766* | (39.5 | 60.5) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| Married/cohabiting | | | | | | | | | | | | | | |
| No | 2767 | 31.6 | 5983 | 68.4 | *8750* | (27.7 | 72.3) | 4154 | 47.5 | 4596 | 52.5 | *8750* | (46.2 | 53.8) |
| Yes | 2559 | 23.1 | 8497 | 76.9 | *11056* | (20.5 | 79.5) | 3989 | 36.1 | 7067 | 63.9 | *11056* | (35.1 | 64.9) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| Ethnicity – White British | | | | | | | | | | | | | | |
| No | 905 | 19.6 | 3703 | 80.4 | *4608* | (17.8 | 82.2) | 2032 | 44.1 | 2576 | 55.9 | *4608* | (43.3 | 56.7) |
| Yes | 4421 | 29.1 | 10777 | 70.9 | *15198* | (25.2 | 74.8) | 6111 | 40.2 | 9087 | 59.8 | *15198* | (38.6 | 61.4) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| Children in household | | | | | | | | | | | | | | |
| No | 4329 | 30.6 | 9808 | 69.4 | *14137* | (26.6 | 73.4) | 5876 | 41.6 | 8261 | 58.4 | *14137* | (40.1 | 59.9) |
| Yes | 997 | 17.6 | 4672 | 82.4 | *5669* | (15.4 | 84.6) | 2267 | 40.0 | 3402 | 60.0 | *5669* | (38.6 | 61.4) |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| Dog Owner | | | | | | | | | | | | | | | |
| No | | 4058 | 26.5 | 11282 | 73.5 | *15340* | (23.1 | 76.9) | 6283 | 41.0 | 9057 | 59.0 | *15340* | (39.6 | 60.4) |
| Yes | | 1268 | 28.4 | 3198 | 71.6 | *4466* | (24.6 | 75.4) | 1860 | 41.6 | 2606 | 58.4 | *4466* | (39.8 | 60.2) |
| | *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| Year | | | | | | | | | | | | | | | |
| 2014/2015 | | 2459 | 26.3 | 6884 | 73.7 | *9343* | (22.7 | 77.3) | 3888 | 41.6 | 5455 | 58.4 | *9343* | (39.8 | 60.2) |
| 2015/2016 | | 2867 | 27.4 | 7596 | 72.6 | *10463* | (24.1 | 75.9) | 4255 | 40.7 | 6208 | 59.3 | *10463* | (39.5 | 60.5) |
| | *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |

Note. Weighted %s (in brackets) take into account sample weights.

**Appendix C: Relationships between time in nature per week and other covariates in models predicting health and wellbeing.**

In order to explore the relationships between our key predictor variable, time spent in nature per week, and other covariates in the models predicting health and wellbeing we split duration into <120 minutes and ≥120 minutes based on the findings discussed elsewhere. The odds ratios (ORs) and 95% confidence intervals (CIs) for the survey weighted binomial logistic regression predicting time spent in nature from the remaining covariates is presented in Supplementary Table S1 below. Results highlight the need to include these variables in our models predicting health and wellbeing because nearly all of them co-varied with time in nature. Specifically, the likelihood of an individual reporting ≥ 120 (vs. <120) minutes last week was higher for individuals: a) who lived in areas with less deprivation and lower air pollution; and b) who were under 65 years old, of higher socio-economic status, without restricted functioning, met weekly physical activity guidelines, were not in full-time employment, whose ethnicity was White-British, had children in the household, and had a dog. Intriguingly, individuals living in the least green quintile were more likely to report ≥ 120mins of recreational contact with nature than individuals living in all four greener quintiles, contrary to a simple, people who live in greener areas are likely to spend more time in nature hypothesis (see also ref. 24 in the main body). The only three variables which did not predict time spent in nature (rurality, sex, year) were retained in the final models for theoretical (e.g. rurality is a key confound of area green space) or statistical (e.g. need to control for survey wave) reasons. Of note, rurality and year were also not significant predictors of health or wellbeing either (though sex was).

*Supplementary Table S2*. The odds ratios (OR) and 95% confidence intervals (CIs) of reporting ≥120 minutes of nature contact per week as a function of area and individual level variables

| | Weekly nature contact (≥120mins vs. <120 mins) | | |
|---|---|---|---|
| | | 95% CIs | |
| | OR | Low | High |
| **Area level variables** | | | |
| *Urbanicity* | | | |
| Rural | 1.07 | 0.91 | 1.24 |
| Urban/town fringe | - | - | - |
| *Neighbourhood green* | | | |
| Greenest quintile | 0.80** | 0.70 | 0.91 |
| Quintile 2 | 0.78*** | 0.70 | 0.88 |
| Quintile 3 | 0.82** | 0.73 | 0.92 |
| Quintile 4 | 0.78*** | 0.70 | 0.88 |
| Least green quintile | - | - | - |
| *Area deprivation* | | | |
| Least deprived | 1.76*** | 1.56 | 1.98 |
| Quintile 2 | 1.57*** | 1.39 | 1.76 |
| Quintile 3 | 1.55*** | 1.38 | 1.73 |
| Quintile 4 | 1.25*** | 1.12 | 1.39 |
| Most deprived | - | - | - |
| *Air pollution* | | | |
| $PM_{10}$ lowest tertile | 1.41*** | 1.29 | 1.55 |

| | | | |
|---|---|---|---|
| $PM_{10}$ middle tertile | 1.26*** | 1.16 | 1.38 |
| $PM_{10}$ highest tertile | - | - | - |
| **Individual variables** | | | |
| *Sex* | | | |
| Male | - | - | - |
| Female | 0.94 | 0.87 | 1.00 |
| *Age* | | | |
| 16-64 years | - | - | - |
| ≥ 65 years | 0.85*** | 0.77 | 0.93 |
| *Socio-economic status* | | | |
| AB (Highest) | 1.98*** | 1.80 | 2.19 |
| C1 | 1.69*** | 1.55 | 1.85 |
| C2 | 1.25*** | 1.14 | 1.38 |
| DE (Lowest) | - | - | - |
| *Restricted functioning* | | | |
| No | 1.46*** | 1.34 | 1.60 |
| Yes | - | - | - |
| *Physically active* | | | |
| No (< 150 mins pw) | - | - | - |
| Yes (≥ 150 mins pw) | 1.90*** | 1.76 | 2.04 |
| *Employed full-time* | | | |
| No | - | - | - |
| Yes | 0.88** | 0.82 | 0.96 |
| *Married/cohabiting* | | | |
| No | - | - | - |
| Yes | 1.14*** | 1.06 | 1.22 |
| *Ethnicity - White British* | | | |
| No | - | - | - |
| Yes | 1.44*** | 1.32 | 1.58 |
| *Children in household* | | | |
| No | - | - | - |
| Yes | 1.31*** | 1.21 | 1.42 |
| *Dog Owner* | | | |
| No | - | - | - |
| Yes | 2.23*** | 2.06 | 2.41 |
| *Year* | | | |
| 2014/2015 | - | - | - |
| 2015/2016 | 0.94 | 0.88 | 1.01 |
| Constant | -2.31 | -2.47 | -2.16 |
| Pseudo $R^2$ | 0.10 | | |
| Valid N | 19,806 | | |

Note. * p<0.05; ** p<0.01; ***p<0.001

**Appendix D: Full details of regression models including all covariates.**

*Supplementary Table S3*. The odds ratios (OR) and 95% confidence intervals (CIs) of reporting good health and high well-being as a function of nature visit duration in the last 7 days

| | Self-reported health (Good vs. poor) | | | | | | Subjective well-being (High vs. low) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unadjusted | 95% CIs | | Adjusted | 95% CIs | | Unadjusted | 95% CIs | | Adjusted | 95% CIs | |
| | OR | Low | High | OR | Low | High | OR | Low | High | OR | Low | High |
| **Nature visit exposure** | | | | | | | | | | | | |
| *Weekly visit duration* | | | | | | | | | | | | |
| ≥ 300 mins | 1.73*** | 1.57 | 1.91 | 1.33*** | 1.18 | 1.50 | 1.42*** | 1.31 | 1.54 | 1.20*** | 1.09 | 1.31 |
| 240-299 mins | 2.10*** | 1.74 | 2.53 | 1.55*** | 1.25 | 1.93 | 1.45*** | 1.24 | 1.68 | 1.25** | 1.07 | 1.46 |
| 180-239 mins | 1.74*** | 1.47 | 2.06 | 1.44*** | 1.18 | 1.76 | 1.33*** | 1.16 | 1.53 | 1.16* | 1.00 | 1.34 |
| 120-179 mins | 2.09*** | 1.79 | 2.44 | 1.59*** | 1.31 | 1.92 | 1.37*** | 1.21 | 1.55 | 1.23** | 1.08 | 1.40 |
| 60-119 mins | 1.56*** | 1.34 | 1.83 | 1.13 | 0.94 | 1.37 | 1.21** | 1.06 | 1.39 | 1.10 | 0.96 | 1.27 |
| 1-59 mins | 1.14 | 0.88 | 1.46 | 1.04 | 0.76 | 1.41 | 1.05 | 0.83 | 1.31 | 0.99 | 0.78 | 1.26 |
| 0 mins | ref | ref | ref | ref | ref | ref | ref | ref | ref | ref | ref | ref |
| **Area level covariates** | | | | | | | | | | | | |
| *Urbanicity* | | | | | | | | | | | | |
| Rural | - | - | - | 1.01 | 0.83 | 1.23 | - | - | - | 1.06 | 0.91 | 1.25 |
| Urban/town fringe | - | - | - | ref | ref | ref | - | - | - | ref | ref | ref |
| *Neighbourhood green* | | | | | | | | | | | | |
| Greenest quintile | - | - | - | 1.05 | 0.89 | 1.23 | - | - | - | 1.15* | 1.02 | 1.30 |
| Quintile 2 | - | - | - | 0.96 | 0.83 | 1.11 | - | - | - | 0.98 | 0.88 | 1.09 |
| Quintile 3 | - | - | - | 0.97 | 0.85 | 1.11 | - | - | - | 1.03 | 0.93 | 1.14 |
| Quintile 4 | - | - | - | 0.99 | 0.87 | 1.13 | - | - | - | 1.02 | 0.92 | 1.13 |
| Least green quintile | - | - | - | ref | ref | ref | - | - | - | ref | ref | ref |
| *Area deprivation* | | | | | | | | | | | | |
| Least deprived | - | - | - | 1.46*** | 1.25 | 1.69 | - | - | - | 1.26*** | 1.13 | 1.41 |
| Quintile 2 | - | - | - | 1.38*** | 1.20 | 1.59 | - | - | - | 1.17** | 1.05 | 1.31 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Quintile 3 | - | - | - | 1.11 | .97 | 1.26 | - | - | - | 1.18** | 1.06 | 1.30 |
| Quintile 4 | - | - | - | 1.15* | 1.01 | 1.29 | - | - | - | 1.07 | 0.97 | 1.18 |
| Most deprived | - | - | - | ref | ref | ref | - | - | - | ref | ref | ref |
| *Air pollution* | | | | | | | | | | | | |
| $PM_{10}$ lowest tertile | - | - | - | 0.96 | 0.86 | 1.08 | - | - | - | 1.07 | 0.98 | 1.17 |
| $PM_{10}$ middle tertile | - | - | - | 1.02 | 0.92 | 1.14 | - | - | - | 1.03 | 0.95 | 1.12 |
| $PM_{10}$ highest tertile | - | - | - | ref | ref | ref | - | - | - | ref | ref | ref |
| **Individual covariates** | | | | | | | | | | | | |
| *Sex* | | | | | | | | | | | | |
| Male | - | - | - | ref | ref | ref | - | - | - | ref | ref | ref |
| Female | - | - | - | 1.18*** | 1.08 | 1.28 | - | - | - | 1.16*** | 1.09 | 1.24 |
| *Age* | | | | | | | | | | | | |
| 16-64 years | - | - | - | ref | ref | ref | - | - | - | ref | ref | ref |
| ≥ 65 years | - | - | - | 0.95 | 0.85 | 1.06 | - | - | - | 1.55*** | 1.42 | 1.69 |
| *Socio-economic status* | | | | | | | | | | | | |
| AB (Highest) | - | - | - | 1.52*** | 1.34 | 1.73 | - | - | - | 1.40*** | 1.27 | 1.54 |
| C1 | - | - | - | 1.40*** | 1.26 | 1.55 | - | - | - | 1.23*** | 1.13 | 1.34 |
| C2 | - | - | - | 1.30*** | 1.16 | 1.45 | - | - | - | 1.14** | 1.05 | 1.24 |
| DE (Lowest) | - | - | - | ref | ref | ref | - | - | - | ref | ref | ref |
| *Restricted functioning* | | | | | | | | | | | | |
| No | - | - | - | 11.55*** | 10.56 | 12.64 | - | - | - | 2.00*** | 1.84 | 2.16 |
| Yes | - | - | - | ref | ref | ref | - | - | - | ref | ref | ref |
| *Physically active* | | | | | | | | | | | | |
| No (< 150 mins pw) | - | - | - | ref | ref | ref | - | - | - | ref | ref | ref |
| Yes (≥ 150 mins pw) | - | - | - | 1.43*** | 1.29 | 1.59 | - | - | - | 1.17*** | 1.08 | 1.26 |
| *Employed full-time* | | | | | | | | | | | | |
| No | - | - | - | ref | ref | ref | - | - | - | ref | ref | ref |
| Yes | - | - | - | 1.49*** | 1.34 | 1.65 | - | - | - | 0.96 | 0.89 | 1.03 |
| *Married/cohabiting* | | | | | | | | | | | | |
| No | - | - | - | ref | ref | ref | - | - | - | ref | ref | ref |
| Yes | - | - | - | 1.05 | 0.96 | 1.15 | - | - | - | 1.45*** | 1.37 | 1.57 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Ethnicity - White British* | | | | | | | | | | | | |
| No | - | - | - | ref | ref | ref | - | - | - | ref | ref | ref |
| Yes | - | - | - | 0.81*** | 0.72 | 0.91 | - | - | - | 1.07 | 0.98 | 1.16 |
| *Children in household* | | | | | | | | | | | | |
| No | - | - | - | ref | ref | ref | - | - | - | ref | ref | ref |
| Yes | - | - | - | 1.26*** | 1.14 | 1.40 | - | - | - | 1.01 | 0.93 | 1.09 |
| *Dog Owner* | | | | | | | | | | | | |
| No | - | - | - | ref | ref | ref | - | - | - | ref | ref | ref |
| Yes | - | - | - | 0.85** | 0.77 | 0.94 | - | - | - | 0.92* | 0.85 | 1.00 |
| *Year* | | | | | | | | | | | | |
| 2014/2015 | - | - | - | ref | ref | ref | - | - | - | ref | ref | ref |
| 2015/2016 | - | - | - | 0.95 | 0.87 | 1.03 | - | - | - | 1.02 | 0.96 | 1.09 |
| Constant | 2.61 | 2.50 | 2.72 | 0.28 | 0.24 | 0.33 | 1.34 | 1.29 | 1.39 | 0.36 | 0.31 | 0.41 |
| Pseudo $R^2$ | 0.01 | | | 0.23 | | | 0.01 | | | 0.05 | | |
| Valid N | 19,806 | | | 19,806 | | | 19,806 | | | 19,806 | | |

Note. * p<0.05; ** p<0.01; ***p<0.001

**Appendix E: Sensitivity analyses modelling outcomes as ordinal and linear variables**

We examined the sensitivity of the models to collapsing the outcome data into binary variables by running ordered logistic models, adjusted for covariates, with the full outcome data. Note that Stata does not allow a test of the proportional odds assumption with sample weighted data, and this is a further reason for our preference for logistic regression models.

*Supplementary Table S4:* Binary and Ordered logistic outcome of the 5 point General Health outcome variable (adjusted model).

| | Self-reported health (Good vs. poor) | | | Self-reported health (Ordinal) | | |
|---|---|---|---|---|---|---|
| | OR | 95% CIs | | OR | 95% CIs | |
| | | Low | High | | Low | High |
| **Nature visit exposure** | | | | | | |
| *Weekly visit duration* | | | | | | |
| ≥ 300 mins | 1.33*** | 1.18 | 1.50 | 1.25*** | 1.16 | 1.36 |
| 240-299 mins | 1.55*** | 1.25 | 1.93 | 1.44*** | 1.26 | 1.66 |
| 180-239 mins | 1.44*** | 1.18 | 1.76 | 1.39*** | 1.22 | 1.59 |
| 120-179 mins | 1.59*** | 1.31 | 1.92 | 1.31*** | 1.17 | 1.47 |
| 60-119 mins | 1.13 | 0.94 | 1.37 | 1.14* | 1.00 | 1.29 |
| 1-59 mins | 1.04 | 0.76 | 1.41 | 1.20 | 0.95 | 1.51 |
| 0 mins | ref | ref | ref | ref | ref | ref |

Notes. Results controlling for: urbanicity, neighbourhood greenspace, area deprivation, background air pollution, sex, age, socioeconomic status, restricted physical functioning, physical activity, employment status, relationship status, ethnicity, children in household, dog ownership and year. * p<0.05; ** p<0.01; ***p<0.001

Although the interpretations of OR differ in the logistic and ordinal regressions, the main patterns observed in the (collapsed) binary logistic outcome for General Health in the main paper are repeated in the ordinal regression: a) exposure of 1-59 minutes showed no significant increased likelihood of reporting (binary outcome) good health, and it showed no significant increased likelihood of reporting (ordinal outcome) better health; b) though the coefficients for exposure of 60-119 mins are almost the same in the binary and ordinal models, (1.13/1.14), this increased likelihood of reporting good health in the binary model was not significant, but this increased likelihood of reporting better health in the ordinal model is significant at p <0.05 (0.043); c) we see a comparable step change in the increased likelihood of both good health in the binary model and better health in the ordinal model for exposure at 120-179; 180-239 and 240-299 mins (compared to at exposure at 1-59 and 60-

119 mins), with OR at these three levels similar to one another in both cases, and significant at p<0.001 in both cases; d) in both the binary and ordinal models we see some decline in the effect at exposures ≥ 300 mins, which is similar to the linear models in Figure 2.

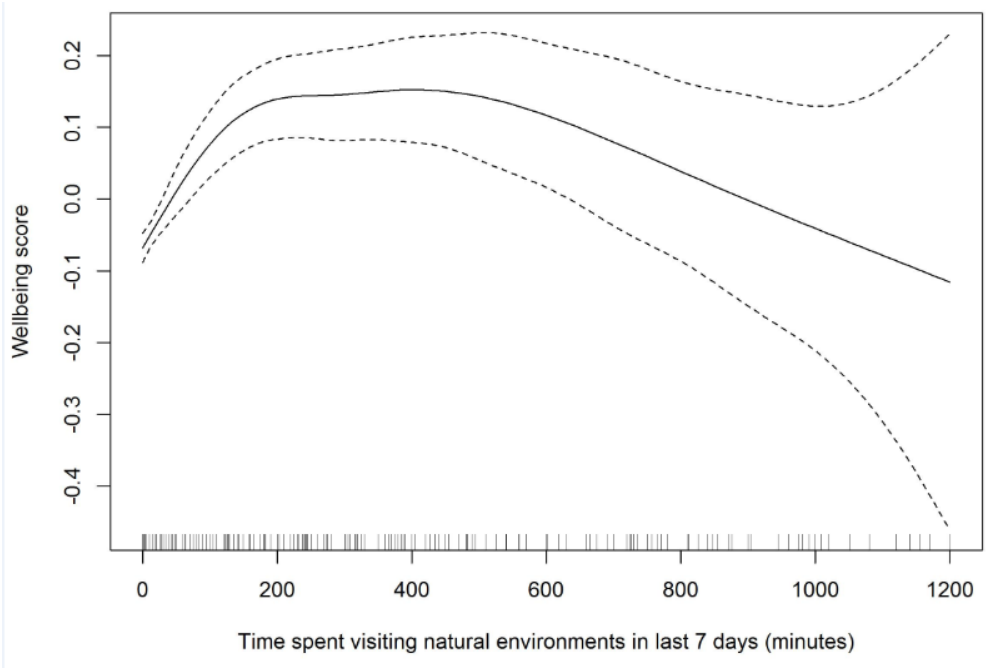
*Supplementary Table S5:* Binary and Ordered logistic outcome of the 11 point Wellbeing outcome variable (adjusted model).

| | Subjective wellbeing (High vs. low) | | | Subjective wellbeing (Ordinal) | | |
|---|---|---|---|---|---|---|
| | OR | 95% CIs | | OR | 95% CIs | |
| | | Low | High | | Low | High |
| *Weekly visit duration* | | | | | | |
| ≥ 300 mins | 1.20*** | 1.09 | 1.31 | 1.19*** | 1.11 | 1.25 |
| 240-299 mins | 1.25** | 1.07 | 1.46 | 1.16* | 1.03 | 1.31 |
| 180-239 mins | 1.16* | 1.00 | 1.34 | 1.22** | 1.09 | 1.36 |
| 120-179 mins | 1.23** | 1.08 | 1.40 | 1.19** | 1.08 | 1.31 |
| 60-119 mins | 1.10 | 0.96 | 1.27 | 1.12* | 1.01 | 1.25 |
| 1-59 mins | 0.99 | 0.78 | 1.26 | 0.92 | 0.75 | 1.13 |
| 0 mins | ref | ref | ref | ref | ref | ref |

Notes. Results controlling for: urbanicity, neighbourhood greenspace, area deprivation, background air pollution, sex, age, socioeconomic status, restricted physical functioning, physical activity, employment status, relationship status, ethnicity, children in household, dog ownership and year. * p<0.05; ** p<0.01; ***p<0.001

The main patterns observed in the (collapsed) binary logistic outcome for Wellbeing in the submission are repeated in the ordinal regression: a) exposure of 1-59 minutes showed no significant increased likelihood of reporting (binary outcome) high wellbeing, and it shows no significant increased likelihood of reporting (ordinal outcome) better wellbeing; b) though the coefficients for exposure of 60-119 mins are almost the same in the binary and ordinal models, (1.1/1.12), this increased likelihood of reporting good health in the binary model was not significant, but this increased likelihood of reporting better health in the ordinal model is significant at p <0.05 (0.038); c) we see a comparable step change in the increased likelihood of both high wellbeing in the binary model and better wellbeing in the ordinal model for exposure at 120-179; 180-239; 240-299 mins and ≥ 300 mins, with OR at these three levels similar to one another in both cases, and significant in both cases.

*Figure D*: The relationship between duration in nature and wellbeing with both variables modelled linearly (note the extremely high confidence intervals beyond ~400 minutes).



**Appendix F: The frequency and percent of respondents in each category of derived binary variables used in stratified analyses.**

*Supplementary Table S6:* The frequency and percent of respondents in each category of derived binary variables used in stratified analyses, and of respondents in each of the ≥120 mins duration composition categories, who reported good/very good health and high well-being.

| | Self-reported health | | | | | | | Subjective well-being (Life satisfaction) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Raw Ns and %s | | | | | (Weighted %s) | | Raw Ns and %s | | | | | (Weighted %s) | |
| | Not good | | Good | | | Not good | Good | Low | | High | | | Low | High |
| | N | % | N | % | Total N | % | % | N | % | N | % | Total N | % | % |
| Weekly visit duration | | | | | | | | | | | | | | |
| ≥120 mins | 1298 | 19.5 | 5372 | 80.5 | *6670* | (17.3 | 82.7) | 2376 | 35.6 | 4294 | 64.4 | *6670* | (34.8 | 65.2) |
| 1-119 mins | 350 | 23.8 | 1118 | 76.2 | *1468* | (21.0 | 79.0) | 594 | 40.5 | 874 | 59.5 | *1468* | (39.0 | 61.0) |
| 0 mins | 3687 | 31.5 | 7990 | 38.5 | *11668* | (27.7 | 72.3) | 5173 | 44.3 | 6495 | 55.7 | *11668* | (42.8 | 57.2) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| Neighbourhood green | | | | | | | | | | | | | | |
| High | 2292 | 26.9 | 6218 | 73.1 | *8510* | (23.6 | 76.4) | 3231 | 38.0 | 5279 | 62.0 | *8510* | (36.5 | 63.5) |
| Low | 3034 | 26.9 | 8262 | 73.1 | *11296* | (23.4 | 76.6) | 4912 | 43.5 | 6384 | 56.5 | *11296* | (42.4 | 57.8) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| Area Deprivation | | | | | | | | | | | | | | |
| High | 3516 | 29.8 | 8280 | 70.2 | *11796* | (26.1 | 73.9) | 5276 | 44.7 | 6520 | 55.3 | *11796* | (43.4 | 56.6) |
| Low | 1810 | 22.6 | 6200 | 77.4 | *8010* | (20.1 | 79.9) | 2867 | 35.8 | 5143 | 64.2 | *8010* | (34.9 | 65.1) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| Socio-economic status | | | | | | | | | | | | | | |
| High | 1653 | 19.2 | 6971 | 80.8 | *8624* | (18.6 | 81.4) | 3093 | 35.9 | 5531 | 64.1 | *8624* | (35.7 | 64.3) |
| Low | 3673 | 32.8 | 7509 | 67.2 | *11182* | (29.2 | 70.8) | 5050 | 45.2 | 6132 | 54.8 | *11182* | (44.3 | 55.7) |
| *Totals* | *5326* | *26.9* | *14480* | *73.1* | *19806* | (*23.5* | *76.5*) | *8143* | *41.1* | *11663* | *58.9* | *19806* | (*39.7* | *60.3*) |
| **Visit frequency** | | | | | | | | | | | | | | |
| ≥120mins per week only | | | | | | | | | | | | | | |
| 1 visit ≥ 120mins | 420 | 18.8 | 1810 | 81.2 | *2230* | (16.4 | 83.6) | 800 | 35.9 | 1430 | 64.1 | *2230* | (35.5 | 64.5) |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 visits ≥ 60 ≤119mins | 67 | 17.5 | 316 | 82.5 | *383* | (16.3 | 83.7) | 132 | 34.5 | 251 | 65.5 | *383* | (35.0 | 65.0) |
| ≥3 visits ≤40mins | 174 | 22.8 | 588 | 77.2 | *762* | (20.3 | 79.7) | 280 | 36.7 | 482 | 63.3% | *762* | (35.6 | 64.5) |
| Totals | 661 | 19.6 | 2714 | 80.4 | *3375* | (17.3 | 82.7) | 1212 | 35.9 | 2163 | 64.1% | *3375* | (35.5 | 64.5) |

Note. Weighted %s (in brackets) take into account sample weights.

**Appendix G: Does the way in which ≥120mins in nature per week is attained matter for health and well-being outcomes?**

To explore whether the manner in which 'high contact' ≥120mins (i.e. ≥120mins) was achieved might be important we focused only on those who reported ≥120mins and constructed three exposure/contact groups: a) those who achieved this level in a single visit (≥120mins); those who achieved it in two visits (≥ 60-≤119mins), and those who achieved it in ≥three visits (≥40mins =*ref*). More categories were not possible with the reduced sample, and results were similar if we restricted the sample to only those who reported 120-179mins or all respondents ≥120mins. Supplementary Table S7 presents the results below. Although the odds of good health were significantly higher for those who achieved the threshold on just one vs. ≥three visits in the unadjusted model, this effect disappeared in the fully adjusted model. There were no differences in either model for well-being. In short, the odds of reporting positive health and well-being outcomes were unrelated to how the threshold of weekly nature contact was achieved. Preliminary analysis (not presented) also found no effect of whether the visits involved active (e.g. jogging) or inactive (e.g. enjoying the view from a car) activities. Moreover, it was also not possible to see whether nature visit companions (e.g. alone, other adults, children) were important because companion data were not collected in the same sampling frame as the health and well-being outcomes. Given the potential importance of social connectedness from nature visits (Kaźmierczak, 2013; Sugiyama, Leslie, Giles-Corti, & Owen, 2008; Weinstein, Balmford, DeHaan, et al., 2015) this is something else that will need to be considered in relation to exposure thresholds going forward.

*References*

Kaźmierczak, A. (2013). The contribution of local parks to neighbourhood social ties. *Landscape and Urban Planning*, *109*(1), 31-44

Sugiyama, T., Leslie, E., Giles-Corti, B., & Owen, N. (2008). Associations of neighbourhood greenness with physical and mental health: do walking, social coherence and local social interaction explain the relationships?. *Journal of Epidemiology and Community Health*, *62*(5), e9-e9.

Weinstein, N., Balmford, A., DeHaan, C. R., Gladwell, V., Bradbury, R. B., & Amano, T. (2015). Seeing community for the trees: the links among contact with natural environments, community cohesion, and crime. *BioScience*, *65*(12), 1141-1153.

*Supplementary Table S7:* The odds ratios (OR) and 95% confidence intervals (CIs) of reporting good health and high well-being among those who visited nature ≥ 120mins in the last 7 days as a function of visit distribution

| | Self-reported health (Good vs. poor) | | | | | | Subjective well-being (High vs. low) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unadjusted | | | Adjusted[a] | | | Unadjusted | | | Adjusted[a] | | |
| | | 95% CIs | | | 95% CIs | | | 95% CIs | | | 95% CIs | |
| | OR | Low | High | OR | Low | High | OR | Low | High | OR | Low | High |
| **Visit distribution** | | | | | | | | | | | | |
| *≥120mins per week* | | | | | | | | | | | | |
| 1 visit ≥ 120mins | 1.30** | 1.05 | 1.61 | 1.07 | 0.81 | 1.42 | 1.00 | 0.84 | 1.20 | 1.01 | 0.81 | 1.25 |
| 2 visits ≥ 60 ≤119mins | 1.30 | 0.94 | 1.82 | 0.96 | 0.65 | 1.44 | 1.02 | 0.78 | 1.34 | 0.97 | 0.73 | 1.30 |
| ≥3 visits ≤40mins | ref | ref | ref | ref | ref | ref | ref | ref | ref | ref | ref | ref |
| *Covariates* | | | | | | | | | | | | |
| Area | NO | | | NO | | | NO | | | NO | | |
| Individual | NO | | | YES | | | NO | | | YES | | |
| Constant | 3.93 | | | 0.40 | | | 1.81 | | | 0.57 | | |
| Pseudo $R^2$ | .00 | | | .16 | | | .00 | | | .04 | | |
| Valid N | 3,375 | | | 3,375 | | | 3,375 | | | 3,375 | | |

Note. [a]Full models available on request.