性別、中高別、学年別にみた使用する
インターネット使用制限の失敗（質問67－3）

| 性別 | 中高別 | | インターネット使用制限の失敗 | | | |
|---|---|---|---|---|---|---|
| | | | なかった | あった | 不明 | 合計 |
| 男 | 中学 学年 | 1年生 | 度数 | 1253 | 242 | 39 | 1534 |
| | | | 学年 の % | 81.7 | 15.8 | 2.5 | 100.0 |
| | | 2年生 | 度数 | 1279 | 265 | 24 | 1568 |
| | | | 学年 の % | 81.6 | 16.9 | 1.5 | 100.0 |
| | | 3年生 | 度数 | 1074 | 314 | 17 | 1405 |
| | | | 学年 の % | 76.4 | 22.3 | 1.2 | 100.0 |
| | | 不明 | 度数 | 13 | 4 | 1 | 18 |
| | | | 学年 の % | 72.2 | 22.2 | 5.6 | 100.0 |
| | | 合計 | 度数 | 3619 | 825 | 81 | 4525 |
| | | | 学年 の % | 80.0 | 18.2 | 1.8 | 100.0 |
| | 高校 学年 | 1年生 | 度数 | 1561 | 481 | 22 | 2064 |
| | | | 学年 の % | 75.6 | 23.3 | 1.1 | 100.0 |
| | | 2年生 | 度数 | 1575 | 435 | 15 | 2025 |
| | | | 学年 の % | 77.8 | 21.5 | 0.7 | 100.0 |
| | | 3年生 | 度数 | 1509 | 494 | 16 | 2019 |
| | | | 学年 の % | 74.7 | 24.5 | 0.8 | 100.0 |
| | | 不明 | 度数 | 11 | 4 | 1 | 16 |
| | | | 学年 の % | 68.8 | 25.0 | 6.3 | 100.0 |
| | | 合計 | 度数 | 4656 | 1414 | 54 | 6124 |
| | | | 学年 の % | 76.0 | 23.1 | 0.9 | 100.0 |
| 女 | 中学 学年 | 1年生 | 度数 | 1100 | 285 | 22 | 1407 |
| | | | 学年 の % | 78.2 | 20.3 | 1.6 | 100.0 |
| | | 2年生 | 度数 | 1129 | 325 | 11 | 1465 |
| | | | 学年 の % | 77.1 | 22.2 | 0.8 | 100.0 |
| | | 3年生 | 度数 | 956 | 404 | 12 | 1372 |
| | | | 学年 の % | 69.7 | 29.4 | 0.9 | 100.0 |
| | | 不明 | 度数 | 25 | 10 | 0 | 35 |
| | | | 学年 の % | 71.4 | 28.6 | 0.0 | 100.0 |
| | | 合計 | 度数 | 3210 | 1024 | 45 | 4279 |
| | | | 学年 の % | 75.0 | 23.9 | 1.1 | 100.0 |
| | 高校 学年 | 1年生 | 度数 | 1491 | 777 | 13 | 2281 |
| | | | 学年 の % | 65.4 | 34.1 | 0.6 | 100.0 |
| | | 2年生 | 度数 | 1507 | 685 | 12 | 2204 |
| | | | 学年 の % | 68.4 | 31.1 | 0.5 | 100.0 |
| | | 3年生 | 度数 | 1592 | 760 | 18 | 2370 |
| | | | 学年 の % | 67.2 | 32.1 | 0.8 | 100.0 |
| | | 不明 | 度数 | 21 | 5 | 0 | 26 |
| | | | 学年 の % | 80.8 | 19.2 | 0.0 | 100.0 |
| | | 合計 | 度数 | 4611 | 2227 | 43 | 6881 |
| | | | 学年 の % | 67.0 | 32.4 | 0.6 | 100.0 |

性別、中高別、学年別にみた使用する
インターネットの使用制限に伴う不快感情(質問67－4)

| 性別 | 中高別 | | | インターネット使用制限に伴う不快感情 | | | |
|---|---|---|---|---|---|---|---|
| | | | | いいえ | はい | 不明 | 合計 |
| 男 | 中学 学年 | 1年生 | 度数 | 1100 | 285 | 22 | 1407 |
| | | | 学年 の % | 78.2 | 20.3 | 1.6 | 100.0 |
| | | 2年生 | 度数 | 1129 | 325 | 11 | 1465 |
| | | | 学年 の % | 77.1 | 22.2 | 0.8 | 100.0 |
| | | 3年生 | 度数 | 956 | 404 | 12 | 1372 |
| | | | 学年 の % | 69.7 | 29.4 | 0.9 | 100.0 |
| | | 不明 | 度数 | 25 | 10 | 0 | 35 |
| | | | 学年 の % | 71.4 | 28.6 | 0.0 | 100.0 |
| | | 合計 | 度数 | 3210 | 1024 | 45 | 4279 |
| | | | 学年 の % | 75.0 | 23.9 | 1.1 | 100.0 |
| | 高校 学年 | 1年生 | 度数 | 1491 | 777 | 13 | 2281 |
| | | | 学年 の % | 65.4 | 34.1 | 0.6 | 100.0 |
| | | 2年生 | 度数 | 1507 | 685 | 12 | 2204 |
| | | | 学年 の % | 68.4 | 31.1 | 0.5 | 100.0 |
| | | 3年生 | 度数 | 1592 | 760 | 18 | 2370 |
| | | | 学年 の % | 67.2 | 32.1 | 0.8 | 100.0 |
| | | 不明 | 度数 | 21 | 5 | 0 | 26 |
| | | | 学年 の % | 80.8 | 19.2 | 0.0 | 100.0 |
| | | 合計 | 度数 | 4611 | 2227 | 43 | 6881 |
| | | | 学年 の % | 67.0 | 32.4 | 0.6 | 100.0 |
| 女 | 中学 学年 | 1年生 | 度数 | 1238 | 147 | 22 | 1407 |
| | | | 学年 の % | 88.0 | 10.4 | 1.6 | 100.0 |
| | | 2年生 | 度数 | 1256 | 200 | 9 | 1465 |
| | | | 学年 の % | 85.7 | 13.7 | 0.6 | 100.0 |
| | | 3年生 | 度数 | 1141 | 219 | 12 | 1372 |
| | | | 学年 の % | 83.2 | 16.0 | 0.9 | 100.0 |
| | | 不明 | 度数 | 30 | 5 | 0 | 35 |
| | | | 学年 の % | 85.7 | 14.3 | 0.0 | 100.0 |
| | | 合計 | 度数 | 3665 | 571 | 43 | 4279 |
| | | | 学年 の % | 85.7 | 13.3 | 1.0 | 100.0 |
| | 高校 学年 | 1年生 | 度数 | 1826 | 447 | 8 | 2281 |
| | | | 学年 の % | 80.1 | 19.6 | 0.4 | 100.0 |
| | | 2年生 | 度数 | 1789 | 404 | 11 | 2204 |
| | | | 学年 の % | 81.2 | 18.3 | 0.5 | 100.0 |
| | | 3年生 | 度数 | 1952 | 402 | 16 | 2370 |
| | | | 学年 の % | 82.4 | 17.0 | 0.7 | 100.0 |
| | | 不明 | 度数 | 21 | 5 | 0 | 26 |
| | | | 学年 の % | 80.8 | 19.2 | 0.0 | 100.0 |
| | | 合計 | 度数 | 5588 | 1258 | 35 | 6881 |
| | | | 学年 の % | 81.2 | 18.3 | 0.5 | 100.0 |

性別、中高別、学年別にみた使用する
意図したよりも長いインターネット使用（質問67－5）

| 性別 | 中高別 | | 意図したよりも長いインターネット使用 | | | |
|---|---|---|---|---|---|---|
| | | | いいえ | はい | 不明 | 合計 |
| 男 | 中学 学年 | 1年生 度数 | 1291 | 199 | 44 | 1534 |
| | | 1年生 学年 の % | 84.2 | 13.0 | 2.9 | 100.0 |
| | | 2年生 度数 | 1236 | 312 | 20 | 1568 |
| | | 2年生 学年 の % | 78.8 | 19.9 | 1.3 | 100.0 |
| | | 3年生 度数 | 1038 | 346 | 21 | 1405 |
| | | 3年生 学年 の % | 73.9 | 24.6 | 1.5 | 100.0 |
| | | 不明 度数 | 13 | 4 | 1 | 18 |
| | | 不明 学年 の % | 72.2 | 22.2 | 5.6 | 100.0 |
| | | 合計 度数 | 3578 | 861 | 86 | 4525 |
| | | 合計 学年 の % | 79.1 | 19.0 | 1.9 | 100.0 |
| | 高校 学年 | 1年生 度数 | 1362 | 681 | 21 | 2064 |
| | | 1年生 学年 の % | 66.0 | 33.0 | 1.0 | 100.0 |
| | | 2年生 度数 | 1308 | 699 | 18 | 2025 |
| | | 2年生 学年 の % | 64.6 | 34.5 | 0.9 | 100.0 |
| | | 3年生 度数 | 1296 | 710 | 13 | 2019 |
| | | 3年生 学年 の % | 64.2 | 35.2 | 0.6 | 100.0 |
| | | 不明 度数 | 10 | 5 | 1 | 16 |
| | | 不明 学年 の % | 62.5 | 31.3 | 6.3 | 100.0 |
| | | 合計 度数 | 3976 | 2095 | 53 | 6124 |
| | | 合計 学年 の % | 64.9 | 34.2 | 0.9 | 100.0 |
| 女 | 中学 学年 | 1年生 度数 | 1096 | 277 | 34 | 1407 |
| | | 1年生 学年 の % | 77.9 | 19.7 | 2.4 | 100.0 |
| | | 2年生 度数 | 1019 | 426 | 20 | 1465 |
| | | 2年生 学年 の % | 69.6 | 29.1 | 1.4 | 100.0 |
| | | 3年生 度数 | 933 | 423 | 16 | 1372 |
| | | 3年生 学年 の % | 68.0 | 30.8 | 1.2 | 100.0 |
| | | 不明 度数 | 28 | 7 | 0 | 35 |
| | | 不明 学年 の % | 80.0 | 20.0 | 0.0 | 100.0 |
| | | 合計 度数 | 3076 | 1133 | 70 | 4279 |
| | | 合計 学年 の % | 71.9 | 26.5 | 1.6 | 100.0 |
| | 高校 学年 | 1年生 度数 | 1284 | 986 | 11 | 2281 |
| | | 1年生 学年 の % | 56.3 | 43.2 | 0.5 | 100.0 |
| | | 2年生 度数 | 1227 | 961 | 16 | 2204 |
| | | 2年生 学年 の % | 55.7 | 43.6 | 0.7 | 100.0 |
| | | 3年生 度数 | 1307 | 1036 | 27 | 2370 |
| | | 3年生 学年 の % | 55.1 | 43.7 | 1.1 | 100.0 |
| | | 不明 度数 | 14 | 12 | 0 | 26 |
| | | 不明 学年 の % | 53.8 | 46.2 | 0.0 | 100.0 |
| | | 合計 度数 | 3832 | 2995 | 54 | 6881 |
| | | 合計 学年 の % | 55.7 | 43.5 | 0.8 | 100.0 |

性別、中高別、学年別にみた
インターネットによる日常の活動への問題（質問67－6）

| 性別 | 中高別 | | | インターネットによる日常の活動への問題 | | | |
|---|---|---|---|---|---|---|---|
| | | | | なかった | あった | 不明 | 合計 |
| 男 | 中学 学年 | 1年生 | 度数 | 1449 | 49 | 36 | 1534 |
| | | | 学年 の % | 94.5 | 3.2 | 2.3 | 100.0 |
| | | 2年生 | 度数 | 1502 | 45 | 21 | 1568 |
| | | | 学年 の % | 95.8 | 2.9 | 1.3 | 100.0 |
| | | 3年生 | 度数 | 1317 | 70 | 18 | 1405 |
| | | | 学年 の % | 93.7 | 5.0 | 1.3 | 100.0 |
| | | 不明 | 度数 | 15 | 2 | 1 | 18 |
| | | | 学年 の % | 83.3 | 11.1 | 5.6 | 100.0 |
| | | 合計 | 度数 | 4283 | 166 | 76 | 4525 |
| | | | 学年 の % | 94.7 | 3.7 | 1.7 | 100.0 |
| | 高校 学年 | 1年生 | 度数 | 1914 | 131 | 19 | 2064 |
| | | | 学年 の % | 92.7 | 6.3 | 0.9 | 100.0 |
| | | 2年生 | 度数 | 1895 | 117 | 13 | 2025 |
| | | | 学年 の % | 93.6 | 5.8 | 0.6 | 100.0 |
| | | 3年生 | 度数 | 1884 | 122 | 13 | 2019 |
| | | | 学年 の % | 93.3 | 6.0 | 0.6 | 100.0 |
| | | 不明 | 度数 | 13 | 2 | 1 | 16 |
| | | | 学年 の % | 81.3 | 12.5 | 6.3 | 100.0 |
| | | 合計 | 度数 | 5706 | 372 | 46 | 6124 |
| | | | 学年 の % | 93.2 | 6.1 | 0.8 | 100.0 |
| 女 | 中学 学年 | 1年生 | 度数 | 1350 | 34 | 23 | 1407 |
| | | | 学年 の % | 95.9 | 2.4 | 1.6 | 100.0 |
| | | 2年生 | 度数 | 1397 | 60 | 8 | 1465 |
| | | | 学年 の % | 95.4 | 4.1 | 0.5 | 100.0 |
| | | 3年生 | 度数 | 1289 | 70 | 13 | 1372 |
| | | | 学年 の % | 94.0 | 5.1 | 0.9 | 100.0 |
| | | 不明 | 度数 | 32 | 3 | 0 | 35 |
| | | | 学年 の % | 91.4 | 8.6 | 0.0 | 100.0 |
| | | 合計 | 度数 | 4068 | 167 | 44 | 4279 |
| | | | 学年 の % | 95.1 | 3.9 | 1.0 | 100.0 |
| | 高校 学年 | 1年生 | 度数 | 2114 | 161 | 6 | 2281 |
| | | | 学年 の % | 92.7 | 7.1 | 0.3 | 100.0 |
| | | 2年生 | 度数 | 2019 | 176 | 9 | 2204 |
| | | | 学年 の % | 91.6 | 8.0 | 0.4 | 100.0 |
| | | 3年生 | 度数 | 2186 | 169 | 15 | 2370 |
| | | | 学年 の % | 92.2 | 7.1 | 0.6 | 100.0 |
| | | 不明 | 度数 | 25 | 1 | 0 | 26 |
| | | | 学年 の % | 96.2 | 3.8 | 0.0 | 100.0 |
| | | 合計 | 度数 | 6344 | 507 | 30 | 6881 |
| | | | 学年 の % | 92.2 | 7.4 | 0.4 | 100.0 |

性別、中高別、学年別にみた
インターネットへの熱中を隠すための嘘(質問67－7)

| 性別 | 中高別 | | | インターネットへの熱中を隠すための嘘 | | | |
|---|---|---|---|---|---|---|---|
| | | | | なかった | あった | 不明 | 合計 |
| 男 | 中学 学年 | 1年生 | 度数 | 1427 | 72 | 35 | 1534 |
| | | | 学年 の % | 93.0 | 4.7 | 2.3 | 100.0 |
| | | 2年生 | 度数 | 1490 | 64 | 14 | 1568 |
| | | | 学年 の % | 95.0 | 4.1 | 0.9 | 100.0 |
| | | 3年生 | 度数 | 1262 | 126 | 17 | 1405 |
| | | | 学年 の % | 89.8 | 9.0 | 1.2 | 100.0 |
| | | 不明 | 度数 | 15 | 2 | 1 | 18 |
| | | | 学年 の % | 83.3 | 11.1 | 5.6 | 100.0 |
| | | 合計 | 度数 | 4194 | 264 | 67 | 4525 |
| | | | 学年 の % | 92.7 | 5.8 | 1.5 | 100.0 |
| | 高校 学年 | 1年生 | 度数 | 1840 | 206 | 18 | 2064 |
| | | | 学年 の % | 89.1 | 10.0 | 0.9 | 100.0 |
| | | 2年生 | 度数 | 1812 | 201 | 12 | 2025 |
| | | | 学年 の % | 89.5 | 9.9 | 0.6 | 100.0 |
| | | 3年生 | 度数 | 1811 | 197 | 11 | 2019 |
| | | | 学年 の % | 89.7 | 9.8 | 0.5 | 100.0 |
| | | 不明 | 度数 | 13 | 2 | 1 | 16 |
| | | | 学年 の % | 81.3 | 12.5 | 6.3 | 100.0 |
| | | 合計 | 度数 | 5476 | 606 | 42 | 6124 |
| | | | 学年 の % | 89.4 | 9.9 | 0.7 | 100.0 |
| 女 | 中学 学年 | 1年生 | 度数 | 1305 | 85 | 17 | 1407 |
| | | | 学年 の % | 92.8 | 6.0 | 1.2 | 100.0 |
| | | 2年生 | 度数 | 1333 | 125 | 7 | 1465 |
| | | | 学年 の % | 91.0 | 8.5 | 0.5 | 100.0 |
| | | 3年生 | 度数 | 1232 | 128 | 12 | 1372 |
| | | | 学年 の % | 89.8 | 9.3 | 0.9 | 100.0 |
| | | 不明 | 度数 | 28 | 7 | 0 | 35 |
| | | | 学年 の % | 80.0 | 20.0 | 0.0 | 100.0 |
| | | 合計 | 度数 | 3898 | 345 | 36 | 4279 |
| | | | 学年 の % | 91.1 | 8.1 | 0.8 | 100.0 |
| | 高校 学年 | 1年生 | 度数 | 1990 | 283 | 8 | 2281 |
| | | | 学年 の % | 87.2 | 12.4 | 0.4 | 100.0 |
| | | 2年生 | 度数 | 1959 | 234 | 11 | 2204 |
| | | | 学年 の % | 88.9 | 10.6 | 0.5 | 100.0 |
| | | 3年生 | 度数 | 2103 | 253 | 14 | 2370 |
| | | | 学年 の % | 88.7 | 10.7 | 0.6 | 100.0 |
| | | 不明 | 度数 | 24 | 2 | 0 | 26 |
| | | | 学年 の % | 92.3 | 7.7 | 0.0 | 100.0 |
| | | 合計 | 度数 | 6076 | 772 | 33 | 6881 |
| | | | 学年 の % | 88.3 | 11.2 | 0.5 | 100.0 |

性別、中高別、学年別にみた
不快感情の回避としてのインターネット使用（質問67－8）

| 性別 | 中高別 | | | 不快感情の回避としてのインターネット使用 | | | |
|---|---|---|---|---|---|---|---|
| | | | | いいえ | はい | 不明 | 合計 |
| 男 | 中学 学年 | 1年生 | 度数 | 1447 | 60 | 27 | 1534 |
| | | | 学年 の % | 94.3 | 3.9 | 1.8 | 100.0 |
| | | 2年生 | 度数 | 1477 | 76 | 15 | 1568 |
| | | | 学年 の % | 94.2 | 4.8 | 1.0 | 100.0 |
| | | 3年生 | 度数 | 1283 | 106 | 16 | 1405 |
| | | | 学年 の % | 91.3 | 7.5 | 1.1 | 100.0 |
| | | 不明 | 度数 | 14 | 3 | 1 | 18 |
| | | | 学年 の % | 77.8 | 16.7 | 5.6 | 100.0 |
| | | 合計 | 度数 | 4221 | 245 | 59 | 4525 |
| | | | 学年 の % | 93.3 | 5.4 | 1.3 | 100.0 |
| | 高校 学年 | 1年生 | 度数 | 1804 | 242 | 18 | 2064 |
| | | | 学年 の % | 87.4 | 11.7 | 0.9 | 100.0 |
| | | 2年生 | 度数 | 1770 | 243 | 12 | 2025 |
| | | | 学年 の % | 87.4 | 12.0 | 0.6 | 100.0 |
| | | 3年生 | 度数 | 1770 | 237 | 12 | 2019 |
| | | | 学年 の % | 87.7 | 11.7 | 0.6 | 100.0 |
| | | 不明 | 度数 | 14 | 1 | 1 | 16 |
| | | | 学年 の % | 87.5 | 6.3 | 6.3 | 100.0 |
| | | 合計 | 度数 | 5358 | 723 | 43 | 6124 |
| | | | 学年 の % | 87.5 | 11.8 | 0.7 | 100.0 |
| 女 | 中学 学年 | 1年生 | 度数 | 1293 | 96 | 18 | 1407 |
| | | | 学年 の % | 91.9 | 6.8 | 1.3 | 100.0 |
| | | 2年生 | 度数 | 1264 | 193 | 8 | 1465 |
| | | | 学年 の % | 86.3 | 13.2 | 0.5 | 100.0 |
| | | 3年生 | 度数 | 1178 | 185 | 9 | 1372 |
| | | | 学年 の % | 85.9 | 13.5 | 0.7 | 100.0 |
| | | 不明 | 度数 | 28 | 7 | 0 | 35 |
| | | | 学年 の % | 80.0 | 20.0 | 0.0 | 100.0 |
| | | 合計 | 度数 | 3763 | 481 | 35 | 4279 |
| | | | 学年 の % | 87.9 | 11.2 | 0.8 | 100.0 |
| | 高校 学年 | 1年生 | 度数 | 1850 | 424 | 7 | 2281 |
| | | | 学年 の % | 81.1 | 18.6 | 0.3 | 100.0 |
| | | 2年生 | 度数 | 1723 | 470 | 11 | 2204 |
| | | | 学年 の % | 78.2 | 21.3 | 0.5 | 100.0 |
| | | 3年生 | 度数 | 1842 | 516 | 12 | 2370 |
| | | | 学年 の % | 77.7 | 21.8 | 0.5 | 100.0 |
| | | 不明 | 度数 | 22 | 4 | 0 | 26 |
| | | | 学年 の % | 84.6 | 15.4 | 0.0 | 100.0 |
| | | 合計 | 度数 | 5437 | 1414 | 30 | 6881 |
| | | | 学年 の % | 79.0 | 20.5 | 0.4 | 100.0 |

# 資料

# Age verification cards fail to fully prevent minors from accessing tobacco products

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## ABSTRACT

**Background** Proper age verification can prevent minors from accessing tobacco products. For this reason, electronic locking devices based on a proof-of age system utilising cards were installed in almost every tobacco vending machine across Japan and Germany to restrict sales to minors.

**Objective** We aimed to clarify the associations between amount smoked by high school students and the usage of age verification cards by conducting a nationwide cross-sectional survey of students in Japan.

**Methods** This survey was conducted in 2008. We asked high school students, aged 13–18 years, in Japan about their smoking behaviour, where they purchase cigarettes, if or if not they have used age verification cards, and if yes, how they obtained this card.

**Results** As the amount smoked increased, the prevalence of purchasing cigarettes from vending machines also rose for both males and females. The percentage of those with experience of using an age verification card was also higher among those who smoked more. Somebody outside of family was the top source of obtaining cards. Surprisingly, around 5% of males and females belonging to the group with highest smoking levels applied for cards themselves.

**Conclusions** Age verification cards cannot fully prevent minors from accessing tobacco products. These findings suggest that a total ban of tobacco vending machines, not an age verification system, is needed to prevent sales to minors.

Smoking among adolescents increases the risk of many diseases and also causes nicotine dependence.[1 2] Restricting tobacco product sales to minors has been identified as an effective form of prevention of tobacco use.[3–6] Countries that have ratified the Framework Convention on Tobacco Control (FCTC) must legally prohibit the introduction of tobacco vending machines to minors, and when appropriate, conduct a total ban of tobacco vending machines.[7] This restriction has spread all over the world together with the implementation of FCTC.

Age verification at both retail stores and vending machines is very important for protecting minors from tobacco marketing. For this reason, electronic locking devices based on a proof-of age system that utilises cards were installed in almost every tobacco vending machine across Japan and Germany to restrict the sales of cigarettes to minors. Cigarettes can now only be purchased upon presentation of the card at vending machines. In Japan, the card is issued by the Tobacco Institute of Japan to people of legal smoking age, which is 20 years or older. A photo of the applicant and a copy of their official identification such as their driving licence are required to apply for the card. Proof-of-age systems on tobacco vending machines in Japan were first introduced on a limited scale in May 2004. This card-based system was then expanded and gradually introduced throughout Japan starting in March 2008. By July 2008, this electronic locking device had been installed in nearly every tobacco vending machine across the nation.

However, few reports study the effects of this card-based age verification mechanism with regard to under-age smoking.[8 9] Thus, we aimed to clarify the relation between smoking behaviour among high school students and their usage of age verification cards by conducting a cross-sectional nationwide survey in Japan.

## METHODS

This survey was a random sampling survey of high schools across Japan in 2008. The methodological details of this survey have been previously reported.[10–12] The number of schools sampled in the 2008 survey was 130 out of 10 955 junior high schools in Japan, and 110 out of 5115 senior high schools. Responses were obtained from 92 junior (school response rate 70.8%) and 80 senior high schools (72.7%). All students enrolled in the sampled schools were subjects of this study. Anonymous questionnaires and envelopes were handed to the students to complete during school hours. Upon completion, the questionnaires were sealed in the envelopes by the students themselves, collected by their teachers and returned to our research group unopened. Of 95 680 responses, 2980 did not have the complete data needed for analysis. Thus, 92 700 eligible responses (of which 46 975 males and 45 725 females) participated in this study. We conducted our survey in October 2008. Therefore, our results do not reflect a transitional phase, but rather a period that is 3 months following full national implementation of the age verification system.

Although Japanese laws forbid smoking by those younger than 20 years old, teenage smoking is frequently observed.[12] Smoking levels among high school students were divided into four categories (non-smokers, occasional smokers, low daily smokers and high daily smokers) based on the questionnaires. Occasional smokers were defined as those who had smoked at least once over the past 30 days, but not on a daily basis. Low and high daily smokers were defined as those who smoked 1–10 cigarettes (low) or 11 cigarettes or more (high) on a daily basis over the past 30 days. On the

questionnaire, we asked current smokers what their most common sources of cigarettes were, and gave examples such as vending machines. Responses pertaining to the prevalence of experiences using an age verification card, and the method of obtaining cards, were extracted from each questionnaire. For method of obtaining cards, we asked respondents to choose from four answers (took it from family without permission, borrowed it from family, borrowed it from somebody other than family and applied for card by him/herself). This study was reviewed and approved by the institutional review board of the Nihon University (No 19-5-0, approved 18 September, 2007).

Gender-specific analysis was performed. The distributions of the sample were also adjusted to reflect the distribution of all high schools in Japan using post-clustering weights. The weighted percentages in the table 1 were calculated by a weighting method based on one-stage stratified cluster sampling.[13] Trend tests were used to analyse the differences in responses per smoking level group. A trend test is used in categorical data analysis when the aim is to assess for the presence of an association between a variable with two categories and a variable with one or more category. The trend test has higher statistical power than a $\chi^2$ test when the suspected trend is correct.[14] Trend tests were also used to adjust data by grade. The Statistical Package for the Social Sciences (SPSS Japan Inc, version 16.0J) was used for the analyses. All probability values were two-tailed and at a 5% level of significance.

## RESULTS

The percentages of occasional smokers, low daily smokers and high daily smokers in this study were as follows. The percentage of occasional smoking among males, excluding those who smoke on a daily basis, was 1.9% for junior high school (JHS) and 4.8% for senior high school (SHS). The percentage of low daily smoking by males was 0.3% for JHS and 2.1% for SHS. The percentage of high daily smoking by males was 0.1% for JHS and 2.6% for SHS. The percentage of occasional smoking by females, excluding those who smoke on a daily basis, was 1.5% for JHS and 3.1% for SHS. The percentage of low daily smoking by females was 0.1% in JHS and 0.9% for SHS. The percentage of high daily smoking by males was 0.4% for JHS and 0.5% for SHS. These results were similar to recent studies on smoking rates among Japanese teenagers.[15] The prevalence of those who had used an age verification card in the past was 963 (30.5%) out of 3158 male smokers and 424 (28.5%) out of 1490 female smokers. The most common source of cards was from somebody other than family, with 442 (14.0%) out of 3158 males responding thus, and 212 (14.2%) of 1490 females answering yes. The second most common source was from family (203 (6.4%) out of 3158 males and 103 (6.9%) out of 1490 females) and the third most common was taking it from family without permission (138 (4.4%) out of 3158 males and 66 (4.4%) out of 1490 females). Applied for card by him/herself came last, with 89 (2.8%) out of 3158 males and 22 (1.5%) out of 1490 females responding thus.

Table 1 shows the usage of vending machines and age verification cards to purchase cigarettes by each category of amount smoked among high school students. The prevalence of purchasing cigarettes mainly from vending machines became higher as the amount smoked increased for both males and females. The percentage of those who had also used an age

**Table 1** Use of vending machines and age verification cards for purchasing cigarettes, analysed by categories of smoking levels observed in a 2008 national survey of high school students in Japan

| **Male** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Category of smoker | Total | | Occasional smokers | | Low daily smokers 1–10 cigarettes per day | | High daily smokers 11 cigarettes and more per day | | |
| | Unweighted | Weighted* | Unweighted | Weighted* | Unweighted | Weighted* | Unweighted | Weighted* | p Value† |
| Number | 3158 (100.0%) | | 1692 (100.0%) | | 660 (100.0%) | | 806 (100.0%) | | |
| Purchases cigarettes mainly from vending machines | 785 (24.9%) | 30.6% | 314 (18.6%) | 22.9% | 176 (26.7%) | 32.8% | 295 (36.6%) | 45.0% | <0.01 |
| Has used an age verification card before | 963 (30.5%) | 38.4% | 363 (21.5%) | 27.1% | 208 (31.5%) | 39.7% | 392 (48.6%) | 61.2% | <0.01 |
| Method of obtaining verification card | | | | | | | | | |
| Took it from family without permission | 138 (4.4%) | 5.3% | 59 (3.5%) | 4.2% | 20 (3.0%) | 3.6% | 59 (7.3%) | 8.8% | <0.01 |
| Borrowed it from family | 203 (6.4%) | 7.6% | 61 (3.6%) | 4.2% | 49 (7.4%) | 8.7% | 93 (11.5%) | 13.6% | <0.01 |
| Borrowed it from somebody other than family | 442 (14.0%) | 17.2% | 149 (8.8%) | 10.8% | 105 (15.9%) | 19.6% | 188 (23.3%) | 28.7% | <0.01 |
| Applied by himself | 89 (2.8%) | 2.9% | 35 (2.1%) | 2.2% | 7 (1.1%) | 1.1% | 47 (5.5%) | 5.7% | <0.01 |
| **Female** | | | | | | | | | |
| Category of smoker | Total | | Occasional smokers | | Low daily smokers 1–10 cigarettes per day | | High daily smokers 11 cigarettes and more per day | | |
| | Unweighted | Weighted* | Unweighted | Weighted* | Unweighted | Weighted* | Unweighted | Weighted* | p Value† |
| Number | 3158 (100.0%) | | 987 (100.0%) | | 258 (100.0%) | | 245 (100.0%) | | |
| Purchases cigarettes mainly from vending machines | 304 (9.6%) | 9.6% | 160 (16.2%) | 16.2% | 63 (24.4%) | 24.4% | 81 (33.1%) | 33.1% | <0.01 |
| Has used an age verification card before | 424 (13.4%) | 13.4% | 205 (20.8%) | 20.8% | 92 (35.7%) | 35.7% | 127 (51.8%) | 51.8% | <0.01 |
| Method of obtaining verification card | | | | | | | | | |
| Took it from family without permission | 66 (2.1%) | 2.0% | 34 (3.4%) | 3.3% | 8 (3.1%) | 3.0% | 24 (9.8%) | 9.5% | <0.01 |
| Borrowed it from family | 103 (3.3%) | 3.2% | 48 (4.9%) | 4.8% | 21 (8.1%) | 7.9% | 34 (13.9%) | 13.6% | <0.01 |
| Borrowed it from somebody other than family | 212 (6.7%) | 6.8% | 90 (9.1%) | 9.2% | 50 (19.4%) | 19.6% | 72 (29.4%) | 29.7% | <0.01 |
| Applied by herself | 22 (0.7%) | 0.7% | 9 (0.9%) | 0.9% | 1 (0.4%) | 0.4% | 12 (4.9%) | 4.9% | <0.01 |

*The distributions of the sample were adjusted to reflect the distribution of all high schools in Japan using post-clustering weights.
†Analyses were trend tests adjusted by grade.



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verification card, together with smoking levels for both genders, was similar. Although overall numbers of female smokers were lower than males, the percentage of females who had used a card before was equal to or slightly higher than males. The most common source of obtaining cards was from somebody other than the family. For the highest level of smokers, around 5% of both males and females applied for the card themselves. There were statistically significant differences for all research questions, and the amount smoked for both genders by trend-test ($p<0.01$).

## DISCUSSION

We clarified that age verification cards were being used by minors to purchase tobacco from vending machines. The percentages of those using an age verification card increased with the amount smoked for both genders. The most common source of getting the card was from somebody other than family, followed by from family. Surprisingly, around 5% of both gender groups belonging to the highest level of smoking applied for the card themselves.

A previous paper reported that an effective method of preventing minors from smoking was to restrict sales at retailers.[3] Based on such studies, the FCTC included the restriction of sales of cigarettes through vending machines as one of its regulations. Our results show that age verification cards cannot completely prevent minors from accessing tobacco products.

The percentage of those who had used an age verification card became higher with the increased amount smoked for both genders. An age verification card is only supposed to be issued upon confirming that the holder is of legal age. However, high school students were using these cards to purchase cigarettes through vending machines. We also found the popular source for purchasing cigarettes for teenage smokers was still tobacco vending machines. Despite it being forbidden to borrow or lend age verification cards, we think teenagers may be lending cards to one another because the most common source of cards for teenagers was from someone outside of their family. That being said, since the second most common source of cards was family, we relate this misuse on poor management within families. Although the cards were introduced with the aim of preventing minors from purchasing cigarettes from vending machines, it has not fully served its purpose yet. Surprisingly, 5% of students in both genders who were categorised in the highest level of smoking applied for the cards themselves. High school students may submit false statements to receive their cards, and although the cards are supposedly issued upon confirmation that the holders are adults with photo and official identification, the institute that issues the cards may not be verifying this information properly. We could not find details on how high school students received cards that they applied for by themselves. These cards may have been sent to the students owing to clerical error.

There are some limitations in this study. First, we could not assess changes in smoking behaviours among high school students after the introduction of this new card system. Second, our study is a cross-sectional one that does not prove any causal association between smoking behaviour and the use of an age verification card. Finally, our results may be underestimating the actual numbers since we were asking high school students about their smoking behaviours, despite youth tobacco smoking being forbidden by law.

### What this paper adds

**FCTC includes the restriction to sales of cigarettes by tobacco vending machines. Age verification cards to restrict sales through tobacco vending machines were introduced nationally in Japan and Germany. This study shows that age verification cards cannot fully prevent minors from accessing tobacco products.**

In conclusion, our study showed that high school students who smoke use age verification cards to purchase cigarettes through vending machines. Age verification cards cannot entirely prevent minors from accessing tobacco products. We think there needs to be a total ban on tobacco vending machines, and not an age verification system, to prevent tobacco product sales to minors.

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**Competing interests** None.

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# The Association between Use of Mobile Phones after Lights Out and Sleep Disturbances among Japanese Adolescents: A Nationwide Cross-Sectional Survey

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**Study Objective:** The objective of this study was to examine the association between the use of mobile phones after lights out and sleep disturbances among Japanese adolescents.

**Design and Setting:** This study was designed as a cross-sectional survey. The targets were students attending junior and senior high schools throughout Japan. Sample schools were selected by cluster sampling. Self-reported anonymous questionnaires were sent to schools for all students to fill out.

**Participants:** A total of 95,680 adolescents responded. The overall response rate was 62.9%, and 94,777 questionnaires were subjected to analysis.

**Intervention:** N/A

**Measurements and Results:** Daily mobile phone use, even if only for a brief moment every day, was reported by 84.4%. Moreover, as for use of mobile phones after lights out, 8.3% reported using their mobile phone for calling every day and 17.6% reported using it for sending text messages every day. Multiple logistic regression analysis showed that mobile phone use for calling and for sending text messages after lights out was associated with sleep disturbances (short sleep duration, subjective poor sleep quality, excessive daytime sleepiness, and insomnia symptoms) independent of covariates and independent of each other.

**Conclusion:** This study showed that the use of mobile phones for calling and for sending text messages after lights out is associated with sleep disturbances among Japanese adolescents. However, there were some limitations, such as small effect sizes, in this study. More studies that examine the details of this association are necessary to establish strategies for sleep hygiene in the future.

**Keywords:** Sleep disturbance, mobile phone, epidemiology, adolescent, Japan

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## INTRODUCTION

Sleep disturbances increase the risk of physical and mental problems.[1-3] Moreover, sleep disturbances are prevalent not only among adults, but also among adolescents.[4-6] It has been reported that sleep disturbances among adolescents are closely associated with various lifestyle habits such as drinking alcohol, smoking, eating breakfast, and participating in extracurricular activities.[7-9]

Among the lifestyle habits of adolescents that have been highlighted in recent years, the use of mobile phones is one of the most common means of communicating with others. According to the Ministry of Internal Affairs and Communications, the diffusion rate of mobile phones in Japan is 74.8% and 84.0% among the general and adolescent (age between 13-19 years) populations, respectively.[10] Mobile phone use has been reported to be associated with health problems and also with sleep patterns.[11-14] Loughran et al. reported the adverse effects of electromagnetic fields emitted by mobile phones on sleep electroencephalograms.[15] It has also been shown that exposure to mobile phone emissions at nighttime could have an effect on melatonin-onset time.[16] Furthermore, in a prospective cohort study of 1656 Belgian school-aged children, Van den Bulck reported that levels of tiredness after 1 year increased for respondents who used mobile phones more frequently after lights out.[17] Although this study did not demonstrate an association between mobile phone use and sleep disorders, it discussed the possibility of an increase in tiredness levels as a result of sleep disturbance caused by the use of mobile phones after lights out.

Several studies have shown that the use of electronic media, such as television, personal computers (Internet), and computer games, is associated with sleep disorders.[18-20] Nevertheless, many adolescents are not even aware of the adverse effects of using electronic media in bed and mistakenly believe that these media facilitate sleep.[21] Considering that more than 20% of the Belgian adolescents used mobile phones at least once a

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week after lights out,[17] the same observation may also apply to mobile phones and Japanese adolescents. Because mobile phones are frequently used after lights out despite their possible adverse effects on sleep, this lifestyle habit should be fully taken into consideration when formulating preventive strategies against sleep disturbances among adolescents. However, few studies, especially large-scale epidemiologic studies, have examined associations between mobile phone use after lights out and sleep disturbances both in Japan and globally. Therefore, in the present study, we conducted a nationwide survey of Japanese junior and senior high school-aged students to examine the association between the use of mobile phones after lights out and sleep disturbances.

This paper was based on the secondary analysis of data from a national survey. Hence, the association between mobile phone use and sleep disturbance was not the primary aim of this survey.

## METHODS

### Subjects and Sampling

We have previously conducted 4 cross-sectional nationwide surveys (1996, 2000, 2004, and 2007) of lifestyle habits, such as alcohol drinking, smoking, eating, and sleeping, among Japanese adolescents.[8,9,22,23] The present study was the fifth such survey.

For this study, of the 10,955 junior high schools and 5115 senior high schools registered in Japan in May 2008, 130 junior high schools (selection rate: 1.2%) and 110 senior high schools (selection rate: 2.2%) were sampled. We used a stratified, single-stage cluster-sampling method. Using this method, we divided Japan into regional blocks and randomly selected schools from each block. To avoid any sampling bias toward any regional blocks, stratified sampling was performed with regional blocks as the strata. All the students enrolled in the sampled schools were the subjects of this study. The sample size was determined by referring to the response rate and confidence intervals (CIs) based on the variance of the results obtained from the previous studies.[22,23]

In the Japanese education system, children enter primary school at the age of 6 years and leave after 6 years of study. They then enter junior high school for 3 years of study, followed by a further 3 years at senior high school. In this report, the first to third years of junior high school are called the 7th to 9th grades, and the first to third years of senior high school are called the 10th to 12th grades.

### Survey Procedure

We sent a letter to the principal of each selected school asking for cooperation in our survey, along with the same number of questionnaires and envelopes as the number of students enrolled at the school. At each school that agreed to participate in our survey, each class teacher was instructed to protect the privacy of the respondents and to explain to the students that the completed questionnaires would not be seen by the teachers and that it was not necessary for the students to participate if they were not willing to do so. After the questionnaires had been filled in, they were placed in the envelopes provided, which were then sealed with an adhesive flap. Delivery and collection of the questionnaires were entrusted to the teachers, who were instructed to follow the guidelines for conducting the survey. The teachers collected and sent the sealed envelopes back to Nihon University School of Medicine without opening them. The survey period was from December 2008 to the end of January 2009. This survey was approved by the Ethics Committee of Nihon University School of Medicine.

### Response Rates

Replies were obtained from 92 of the 130 junior high schools (school response rate 70.8%) and 80 of the 110 senior high schools (school response rate 72.7%; combined junior high and senior high school response rate 71.7%). A total of 95,680 envelopes were collected. The student response rate as a proportion of students enrolled at the sampled schools was 92.3% for the junior high schools, 83.8% for the senior high schools, and 87.2% as a whole. Accordingly, the overall response rate was 64.1% for the junior high schools, 62.1% for the senior high schools, and 62.9% as a whole. The response rates obtained in this study are similar to those obtained in previous studies using the same method.[8,9,22,23]

Of the collected questionnaires, 903 were excluded because the sex or grade was not specified or the answers were inconsistent. The data for the remaining 94,777 questionnaires were analyzed.

### Measures

The major areas that were included in the questionnaire were (1) personal data, (2) lifestyle, (3) sleep status, (4) mental health status, and (5) use of mobile phones.

#### *Personal data*

The personal data included sex, school grade, and type of school (junior high school/senior high school).

#### *Lifestyle*

The questions related to lifestyle were whether the student ate breakfast (daily/occasionally/never) and whether he or she participated in extracurricular activities (participating/not participating). Moreover, the question, "How many days did you smoke during the previous month?" was included in the questionnaire. If the response to this question was "One day or more," then the student was defined as "smoking." Similarly, the question "How many days did you consume alcoholic beverages during the previous month?" was asked, and if the response was "One day or more," then the student was defined as "drinking alcohol."

#### *Sleep Status*

The sleep-status items included sleep duration, subjective sleep assessment, daytime sleepiness, and insomnia symptoms. Sleep disturbances were estimated on the basis of the sleep-status items. The question about sleep duration was "How many hours on average have you slept at night during the previous month? (less than 5 hours/5 hours or more but less than 6 hours/6 hours or more but less than 7 hours/7 hours or more but less than 8 hours/8 hours or more but less than 9 hours/9 hours or more). If the response to this question was "Less than 6 hours," then the student was defined as having "short sleep

duration." The question about subjective sleep assessment was "How do you assess the quality of your sleep during the previous month?" (very good/good/bad/very bad). If the response to this question was "bad or very bad," then the student was defined as having "subjective poor sleep quality." The question about daytime sleepiness was "Do you feel excessively sleepy during the daytime?" (never/seldom/sometimes/often/always). If the response to this question was "often or always," then the student was defined as having "excessive daytime sleepiness."

The following 3 questions about insomnia symptoms experienced during the previous month were embedded in the questionnaire: (1) "Do you have difficulty falling asleep at night?" (2) "Do you wake up during the night after you have gone to sleep?" (3) "Do you wake up too early in the morning and have difficulty getting back to sleep?"

Each question had 5 possible replies: "never," "seldom," "sometimes," "often," and "always." "Often" and "always" were taken as affirmative answers to the question. Insomnia symptoms were defined as being present when an affirmative answer was obtained for any of the 3 questions. These definitions were determined by referring to the previous studies.[2,9]

#### *Mental health status*

To evaluate the mental health statuses of the respondents, 2 independent factors ("depression/anxiety" and "decrease in positive feeling") included in the 12-item General Health Questionnaire (GHQ-12)[24,25] were used, and 1 item from each factor was selected for the total score. One of the items from the "depression/anxiety" factor (whether the respondent had felt an unusual amount of unhappiness and depression in the previous 30 days) was evaluated (not at all/no more than usual/more than usual/much more than usual). One of the items from the "decrease in positive feeling" factor (whether the respondent was able to enjoy normal activities more than usual in the previous month) was also evaluated (more so than usual/same as usual/less than usual/much less than usual). Each item described a symptom, and there were 4 possible answers: the 2 answers that indicated the absence of the symptom were assigned a rating of 0; the 2 answers that indicated the presence of the symptom were assigned a rating of 1. Thus, the overall score fell within the range of 0 to 2, and, accordingly, the higher the total score, the poorer the state of mental health was considered to be. In the present study, participants who had total scores of 1 or more were considered to have poor mental health. Previous studies have shown that evaluation of mental health status using depression symptoms with the GHQ-12 and with this cutoff point has a sensitivity of 87.0% and a specificity of 85.1%.[26]

#### *Use of mobile phones*

In this study, we used a questionnaire on mobile phone use that contained questions about the frequency of mobile phone use and questions about mobile phone use after lights out. Furthermore, the questions on mobile phone use after lights out included 2 separate questions, one on the use of a mobile phone for calling and the other on the use for sending text messages. The following 3 questions were asked about mobile phone use during the previous month: (1) "How many hours per day did you use your mobile phone (for calling, sending text messages, and Internet browsing)?" (not at all/less than 1 hour/1 hour or more but less than 2 hours/2 hours or more);

(2) "How often did you use your mobile phone (for calling) after lights out?" (not at all/1 to 3 times a month/once a week/a few times a week/every day); and (3) "How often did you use your mobile phone (for sending text messages) after lights out?"(not at all/1 to 3 times a month/once a week/a few times a week/every day).

### Statistical Analyses

First, we tallied the responses to the 3 questions on mobile phone use. Next, we calculated the prevalence and 95% CIs for the 4 types of sleep disturbance: short sleep duration, subjective poor sleep quality, excessive daytime sleepiness, and insomnia symptoms. Finally, logistic-regression analyses were conducted to examine the association between the 2 types of mobile phone use (calling and sending text messages) after lights out and these sleep disturbances. Moreover, the following parameters were used as covariates: sex, grade, alcohol-drinking, smoking, eating breakfast, extracurricular activities, mental health, and the use of mobile phones. Our previous studies reported that the covariates, except the use of mobile phones, were associated with sleep disturbances.[8,9,22,23]

An odds ratio was calculated from both univariate logistic regression analysis and multiple logistic regression analysis with 95% CIs. We set the level of significance at $P < 0.01$. All analyses were performed using SPSS version 17.0 for Windows (SPSS, Inc., Chicago, IL).

## RESULTS

### Responses to the Questions About Use of Mobile Phones

The responses to the questions about duration of mobile phone use during 1 day is shown in Table 1. Daily mobile phone use, even if for only a brief moment every day, was reported by 84.4% (84.2%-84.6%) of the study population, 79.3% (78.9%-79.7%) of the boys, and 89.7% (89.4%-90.0%) of the girls. Moreover, 72.6% (72.2%-73.0%) of junior high school students and 92.9% (92.7%-93.1%) of senior high school students reported using their mobile phones every day. $\chi^2$ TESTS revealed that the girls and senior high school students had more daily mobile phone use ($P < 0.01$).

The responses to the questions about frequency of mobile phone use for calling after lights out are shown in Table 2. In this study, 8.3% (8.1%-8.5%) of the study population, 7.6% (7.4%-7.8%) of the boys, 9.0% (8.8%-9.4%) of the girls, 4.9% (4.7%-5.1%) of junior high school students, and 10.7% (10.4%-11.0%) of senior high school students reported using their mobile phones every day for calling after lights out. $\chi^2$ Tests revealed that the girls and senior high school students had more use of mobile phones for calling after lights out ($P < 0.01$).

The responses to the questions about frequency of mobile phone use for sending text messages after lights out are shown in Table 3. Daily use after lights out was reported by 17.6% (17.4%-17.8%) of the study population, 14% (13.7%-14.3%) of the boys, and 21.3% (20.9%-21.7%) of the girls. Daily use after lights out was also reported by 11.4% (11.1%-11.7%) of junior high school students and 22.1% (21.8%-22.4%) of senior high

school students. $\chi^2$ Tests revealed that the girls and senior high school students had more use of mobile phones for sending text messages after lights out ($P < 0.01$).

**Table 1**—Duration of mobile phone use during 1 day, stratified by sex and grade

| | N | Mobile Phone Use (%) | | | | |
|---|---|---|---|---|---|---|
| | | None | < 1 h | ≥ 1 and 2 < h | ≥ 2 h | Uncertain |
| Male | | | | | | |
| Junior high school | | | | | | |
| 7th grade | 6497 | 42.6 | 35.1 | 9.1 | 12.5 | 0.7 |
| 8th grade | 6769 | 34.6 | 32.5 | 12.9 | 19.2 | 0.8 |
| 9th grade | 6296 | 30.1 | 32.2 | 14.4 | 22.3 | 1.0 |
| Senior high school | | | | | | |
| 10th grade | 10154 | 8.7 | 35.8 | 20.4 | 34.1 | 0.8 |
| 11th grade | 9599 | 8.4 | 34.2 | 21.5 | 35.0 | 0.9 |
| 12th grade | 8762 | 9.3 | 37.5 | 18.6 | 33.5 | 1.1 |
| Total | 48077 | 19.8 | 34.8 | 16.9 | 27.6 | 0.9 |
| Female | | | | | | |
| Junior high school | | | | | | |
| 7th grade | 6769 | 21.8 | 42.3 | 13.8 | 21.5 | 0.7 |
| 8th grade | 6837 | 16.4 | 36.1 | 15.8 | 31.0 | 0.6 |
| 9th grade | 6575 | 14.6 | 34.9 | 16.9 | 32.8 | 0.8 |
| Senior high school | | | | | | |
| 10th grade | 9964 | 3.9 | 27.9 | 22.0 | 45.5 | 0.6 |
| 11th grade | 8662 | 2.9 | 28.6 | 21.9 | 45.8 | 0.8 |
| 12th grade | 7893 | 3.5 | 34.5 | 19.8 | 41.4 | 0.8 |
| **Total** | 46700 | 9.6 | 33.5 | 18.8 | 37.5 | 0.7 |

**Table 2**—Frequency of mobile phones use for calling after lights out, stratified by sex and grade

| | N | Mobile Phone Use For Calling (%) | | | | | |
|---|---|---|---|---|---|---|---|
| | | None | 1-3 times/ mo | Once/ wk | Several times/ wk | Every day | Uncertain |
| Male | | | | | | | |
| Junior high school | | | | | | | |
| 7th grade | 6497 | 86.1 | 3.9 | 2.3 | 3.5 | 2.4 | 1.8 |
| 8th grade | 6769 | 81.6 | 4.5 | 3.1 | 4.9 | 4.4 | 1.5 |
| 9th grade | 6296 | 79.9 | 4.1 | 3.5 | 5.6 | 5.2 | 1.7 |
| Senior high school | | | | | | | |
| 10th grade | 10154 | 68.2 | 6.9 | 6.3 | 8.8 | 8.6 | 1.2 |
| 11th grade | 9599 | 64.1 | 7.6 | 6.3 | 10.3 | 10.5 | 1.2 |
| 12th grade | 8762 | 64.0 | 6.4 | 6.4 | 10.6 | 11.2 | 1.4 |
| Total | 48077 | 72.5 | 5.8 | 5.0 | 7.7 | 7.6 | 1.4 |
| Female | | | | | | | |
| Junior high school | | | | | | | |
| 7th grade | 6769 | 80.6 | 5.6 | 3.0 | 5.5 | 4.1 | 1.3 |
| 8th grade | 6837 | 77.0 | 6.1 | 3.5 | 6.2 | 6.0 | 1.2 |
| 9th grade | 6575 | 74.8 | 6.5 | 3.7 | 6.4 | 7.3 | 1.3 |
| Senior high school | | | | | | | |
| 10th grade | 9964 | 66.5 | 8.4 | 4.8 | 9.2 | 10.2 | 0.9 |
| 11th grade | 8662 | 64.2 | 8.1 | 5.2 | 9.3 | 12.1 | 1.1 |
| 12th grade | 7893 | 63.2 | 8.2 | 5.3 | 9.9 | 12.5 | 0.9 |
| **Total** | 46700 | 70.3 | 7.3 | 4.4 | 8.0 | 9.0 | 1.1 |

### Prevalence of Sleep Disturbances

The prevalence of sleep disturbances with regard to sex and grade are shown in Table 4. The prevalence of short sleep duration was 32.0% (31.7%-32.3%), that of subjective poor sleep quality was 40.2% (39.9%-40.5%), that of excessive daytime sleepiness was 42.2% (41.9%-42.5%), and that of insomnia symptoms was 21.8% (21.5%-22.1%). $\chi^2$ Tests revealed that the girls had more short sleep duration, subjective poor sleep quality, and excessive daytime sleepiness ($P < 0.01$), but there was no significant difference between sexes in regard to insomnia symptoms ($P < 0.13$). Moreover $\chi^2$ tests revealed that senior high school students had more short sleep duration, subjective poor sleep quality, excessive daytime sleepiness, and insomnia symptoms ($P < 0.01$).

## LOGISTIC-REGRESSION ANALYSES

Tables 5 and 6 show the results of the logistic-regression analyses that were used to estimate the association between 2 types of mobile phone use after lights out and sleep disturbances. Univariate logistic analyses revealed that mobile phone use after lights out, either for calling or for sending text messages, was significantly associated with all 4 types of sleep disturbance. Also, multiple logistic-regression analyses revealed that these 2 uses of mobile phones after lights out, each independent from the other factors and from each other, were significantly associated with all 4 types of sleep disturbance.

## DISCUSSION

This study is the first large-scale epidemiologic study that examined the association between mobile phone use after lights out and sleep disorders, and the results of this study appear to be representative of the study population for 3 reasons: (1) the subject schools were selected randomly from among those nationwide, (2) the sample size was very large and the number of analyzed cased exceeded 90,000, and (3) the rate of response to the questionnaires was acceptably highThis study has clarified the actual situation of Japanese adolescents regarding the time spent using mobile phones. We found that the frequency of use of mobile phones was very high among Japanese adolescents and that 84.4% of the study population used mobile phones every day, even if only briefly. This rate closely matches the diffusion rate (84.0%) of mobile phones among Japanese adolescents reported by the Ministry of Internal Affairs and Communications.[10] This study also revealed that more than 30% of

Japanese adolescents used mobile phones for many hours (2 hours or more a day). These results indicate that a mobile phone is one of the electronic media that is closely related to the daily life of Japanese adolescents. The higher frequency of mobile phone use among senior, as compared with junior high school students, may be partly attributable to developmental factors in adolescents and to the expansion of social contacts as a result of advancement to higher education. However, we believe that this difference is primarily attributable to the rules related to the use of mobile phones in Japanese schools. Elementary and junior high schools in Japan generally prohibit students from bringing mobile phones to school, but senior high schools do not.[27] Thus, compared with junior high school students, senior high school students are in a more mobile phone-friendly environment.

As for the use of mobile phones after lights out, 8.3% of the study population reported using their mobile phone for making calls every day, and 17.6% reported using it for sending text messages every day. The frequency of use for sending text messages was especially high, with more than 40% of male and more than 50% of female senior high school students sending text messages at least once a week. Furthermore, 25% of female students reported using their mobile phones for sending text messages every day. The higher frequency of sending text messages, in comparison with calling, may be attributed to the convenience of sending text messages. Unlike calling, sending text messages does not require the sender and receiver to concurrently share communication time. Thus, the sender can communicate with multiple receivers in a short time regardless of the availability of the receiver. Because of these features, sending text

**Table 3**—Frequency of mobile phones use for sending text messages after lights out, stratified by sex and grade

| | | Mobile phone use for sending text messages (%) | | | | | |
|---|---|---|---|---|---|---|---|
| | N | None | 1-3 times/mo | Once/wk | Several times/wk | Every day | Uncertain |
| Male | | | | | | | |
| Junior high school | | | | | | | |
| 7th grade | 6497 | 80.4 | 3.8 | 3.2 | 6.0 | 4.8 | 1.8 |
| 8th grade | 6769 | 71.5 | 5.0 | 3.9 | 9.4 | 8.6 | 1.5 |
| 9th grade | 6296 | 66.9 | 4.8 | 4.7 | 11.0 | 11.1 | 1.5 |
| Senior high school | | | | | | | |
| 10th grade | 10154 | 49.4 | 7.0 | 7.4 | 17.6 | 17.4 | 1.1 |
| 11th grade | 9599 | 49.1 | 6.2 | 7.4 | 17.3 | 18.9 | 1.1 |
| 12th grade | 8762 | 51.7 | 5.8 | 6.9 | 16.7 | 17.7 | 1.3 |
| Total | 48077 | 59.3 | 5.7 | 5.9 | 13.8 | 14.0 | 1.3 |
| Female | | | | | | | |
| Junior high school | | | | | | | |
| 7th grade | 6769 | 64.6 | 7.6 | 5.1 | 11.5 | 10.1 | 1.2 |
| 8th grade | 6837 | 55.3 | 8.7 | 5.1 | 14.6 | 15.5 | 1.0 |
| 9th grade | 6575 | 53.0 | 7.2 | 5.3 | 15.3 | 18.0 | 1.2 |
| Senior high school | | | | | | | |
| 10th grade | 9964 | 38.5 | 7.8 | 7.0 | 20.2 | 25.8 | 0.7 |
| 11th grade | 8662 | 36.8 | 7.6 | 7.5 | 19.4 | 27.8 | 0.8 |
| 12th grade | 7893 | 39.9 | 6.1 | 6.9 | 20.2 | 26.1 | 0.9 |
| Total | 46700 | 46.7 | 7.5 | 6.3 | 17.3 | 21.3 | 0.9 |

**Table 4**—The prevalence of sleep disturbances among Japanese adolescents, stratified by sex and grade[a]

| | Short Sleep Duration | | Subjective Poor Sleep Quality | | Excessive Daytime Sleepiness | | Insomnia Symptom | |
|---|---|---|---|---|---|---|---|---|
| | % | 95% CI | % | 95% CI | % | 95% CI | % | 95% CI |
| Male | | | | | | | | |
| Junior high school | | | | | | | | |
| 7th grade | 12.8 | 12.0–13.6 | 27.9 | 26.8–29.0 | 25.2 | 24.1–26.3 | 19.5 | 18.5–20.5 |
| 8th grade | 17.7 | 16.8–18.6 | 32.3 | 31.2–33.4 | 31.3 | 30.2–32.4 | 21.0 | 20.0–22.0 |
| 9th grade | 26.9 | 25.8–28.0 | 37.9 | 36.7–39.1 | 33.6 | 32.4–34.8 | 23.8 | 22.7–24.9 |
| Senior high school | | | | | | | | |
| 10th grade | 33.2 | 32.3–34.1 | 44.7 | 43.7–45.7 | 46.0 | 45.0–47.0 | 21.5 | 20.7–22.3 |
| 11th grade | 37.4 | 36.4–38.4 | 43.1 | 42.1–44.1 | 45.2 | 44.2–46.2 | 21.4 | 20.6–22.2 |
| 12th grade | 42.9 | 41.9–43.9 | 44.2 | 43.2–45.2 | 44.7 | 43.7–45.7 | 24.2 | 23.3–25.1 |
| Total | 30.0 | 29.6–30.4 | 39.4 | 39.0–39.8 | 39.1 | 38.7–39.5 | 21.9 | 21.5–22.3 |
| Female | | | | | | | | |
| Junior high school | | | | | | | | |
| 7th grade | 16.7 | 15.8–17.6 | 34.3 | 33.2–35.4 | 31.1 | 30.0–32.2 | 18.6 | 17.7–19.5 |
| 8th grade | 22.7 | 21.7–23.7 | 37.0 | 35.9–38.1 | 38.7 | 37.5–39.9 | 21.6 | 20.6–22.6 |
| 9th grade | 31.5 | 30.4–32.6 | 42.0 | 40.8–43.2 | 41.4 | 40.2–42.6 | 23.5 | 22.5–24.5 |
| Senior high school | | | | | | | | |
| 10th grade | 42.0 | 41.0–43.0 | 46.6 | 45.6–47.6 | 53.4 | 52.4–54.4 | 22.1 | 21.3–22.9 |
| 11th grade | 43.4 | 42.4–44.4 | 44.8 | 43.8–45.8 | 52.7 | 51.6–53.8 | 22.9 | 22.0–23.8 |
| 12th grade | 45.8 | 44.7–46.9 | 43.6 | 42.5–44.7 | 52.2 | 51.1–53.3 | 25.1 | 24.1–26.1 |
| Total | 35.0 | 34.6–35.4 | 41.9 | 41.5–42.3 | 46.0 | 45.5–46.5 | 22.4 | 22.0–22.8 |

CI, confidence interval. [a]Subjects with missing data were excluded from the analysis.

**Table 5**—The association between the use of mobile phones after lights out and sleep disturbances among Japanese adolescents[a,b]: short sleep duration and subjective poor sleep quality

| Number of times mobile phones used after lights out, based on type of use | N | Short Sleep Duration | | | | | | Subjective Poor Sleep Quality | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Crude | | | Adjusted | | | Crude | | | Adjusted | | |
| | | OR | 95% CI | P value | OR | 95% CI | P value | OR | 95% CI | P value | OR | 95% CI | P value |
| For calling | | | | < 0.01 | | | < 0.01 | | | < 0.01 | | | < 0.01 |
| 0 | 67646 | 1.00 | | | 1.00 | | | 1.00 | | | 1.00 | | |
| 1-3/mo | 6229 | 1.41 | 1.33–1.48 | | 1.12 | 1.05–1.19 | | 1.40 | 1.33–1.48 | | 1.06 | 1.00–1.13 | |
| 1/wk | 4423 | 1.26 | 1.18–1.34 | | 0.99 | 0.92–1.07 | | 1.31 | 1.23–1.39 | | 1.01 | 0.94–1.08 | |
| Several/wk | 7441 | 1.49 | 1.42–1.56 | | 1.08 | 1.02–1.14 | | 1.57 | 1.49–1.65 | | 1.08 | 1.02–1.14 | |
| Daily | 7853 | 1.94 | 1.85–2.03 | | 1.21 | 1.14–1.28 | | 2.00 | 1.90–2.09 | | 1.22 | 1.15–1.29 | |
| For sending text messages | | | | < 0.01 | | | < 0.01 | | | < 0.01 | | | < 0.01 |
| 0 | 50349 | 1.00 | | | 1.00 | | | 1.00 | | | 1.00 | | |
| 1-3/mo | 6204 | 1.05 | 0.99–1.12 | | 0.87 | 0.81–0.92 | | 1.19 | 1.13–1.26 | | 1.07 | 1.00–1.13 | |
| 1/wk | 5767 | 1.15 | 1.09–1.22 | | 0.88 | 0.83–0.94 | | 1.25 | 1.18–1.32 | | 1.05 | 0.98–1.11 | |
| Several/wk | 14698 | 1.37 | 1.32–1.42 | | 0.97 | 0.93–1.01 | | 1.49 | 1.43–1.54 | | 1.16 | 1.11–1.21 | |
| Daily | 16696 | 1.89 | 1.82–1.96 | | 1.15 | 1.09–1.20 | | 1.95 | 1.88–2.02 | | 1.27 | 1.21–1.33 | |

OR, odds ratio; CI, confidence interval. [a]Adjusted factors include sex, grade, drinking alcohol, smoking, eating breakfast, extracurricular activities, and mental health. [b]Subjects with missing date were excluded from the analysis.

**Table 6**—The association between use of mobile phones after lights out and sleep disturbances among Japanese adolescents: Excessive daytime sleepiness and insomnia symptoms

| Number of times mobile phones used after lights out, based on type of use | N | Excessive Daytime Sleepiness | | | | | | Insomnia Symptom | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Crude | | | Adjusted | | | Crude | | | Adjusted | | |
| | | OR | 95% CI | P value | OR | 95% CI | P value | OR | 95% CI | P value | OR | 95% CI | P value |
| For calling | | | | < 0.01 | | | < 0.01 | | | < 0.01 | | | < 0.01 |
| 0 | 67646 | 1.00 | | | 1.00 | | | 1.00 | | | 1.00 | | |
| 1-3/mo | 6229 | 1.45 | 1.38–1.53 | | 0.98 | 0.92–1.04 | | 1.46 | 1.38–1.55 | | 1.13 | 1.06–1.21 | |
| 1/wk | 4423 | 1.30 | 1.22–1.38 | | 0.91 | 0.85–0.98 | | 1.50 | 1.40–1.61 | | 1.19 | 1.10–1.29 | |
| Several/wk | 7441 | 1.58 | 1.50–1.65 | | 0.98 | 0.93–1.04 | | 1.79 | 1.70–1.89 | | 1.26 | 1.18–1.34 | |
| Daily | 7853 | 2.12 | 2.02–2.22 | | 1.17 | 1.10–1.24 | | 2.47 | 2.35–2.60 | | 1.44 | 1.35–1.53 | |
| For sending text messages | | | | < 0.01 | | | < 0.01 | | | < 0.01 | | | < 0.01 |
| 0 | 50349 | 1.00 | | | 1.00 | | | 1.00 | | | 1.00 | | |
| 1-3/mo | 6204 | 1.40 | 1.32–1.47 | | 1.24 | 1.17–1.31 | | 1.15 | 1.08–1.23 | | 1.07 | 0.99–1.15 | |
| 1/wk | 5767 | 1.39 | 1.32–1.47 | | 1.16 | 1.09–1.23 | | 1.20 | 1.12–1.28 | | 1.02 | 0.95–1.10 | |
| Several/wk | 14698 | 1.74 | 1.68–1.80 | | 1.37 | 1.31–1.43 | | 1.43 | 1.37–1.49 | | 1.12 | 1.07–1.18 | |
| Daily | 16696 | 2.28 | 2.20–2.36 | | 1.50 | 1.43–1.57 | | 2.28 | 2.19–2.37 | | 1.45 | 1.38–1.53 | |

OR, odds ratio; CI, confidence interval. [a]Adjusted factors include sex, grade, drinking alcohol, smoking, eating breakfast, extracurricular activities, and mental health. [b]Subjects with missing date were excluded from the analysis.

messages is regarded as a more accessible communication medium and tends to be preferred over calling, especially in circumstances in which the receiver is less likely to be available for communication. Therefore, it is understandable that, after lights out, the frequency of sending text messages is higher than that of calling.

In this study, to assess the association between mobile phone use after lights out and sleep disturbance, we conducted a multifaceted and comprehensive evaluation of sleep disturbance by focusing on 4 parameters; quantitative index (short sleep duration), qualitative index (subjective poor sleep quality), daytime consequences (excessive daytime sleepiness), and insomnia symptoms and, by using multiple logistic-regression analysis, adjusted for other confounding factors. We found that mobile phone use for calling and for sending text messages after lights out was associated with all sleep disturbances independent of the covariates and independent of each other.

Our finding that mobile phone use after lights out was associated with all forms of sleep disturbance, each different in nature, suggests that the use of mobile phones after lights out has various effects on sleep. Loughran et al.[15] reported that exposure to electromagnetic fields emitted by digital mobile-phone handsets prior to sleep decreased the rapid eye movement (REM) sleep latency and increased the electroencephalogram

spectral power in the 11.5- to 12.25-Hz frequency range during the initial part of sleep following exposure. Furthermore, Wood et al.[16] reported that, although subjects who were actively exposed to mobile-phone emissions showed no significant difference in total nighttime melatonin output relative to sham-exposed subjects, the pre-bedtime melatonin output was significantly lower in the former, indicating a delay in the onset time of melatonin secretion caused by mobile phone emission. These reports suggest that the use of mobile phones after lights out influences physiologic factors such as the sleep electroencephalogram and melatonin-secretion rhythm. Moreover, if communications made using a mobile phone after lights out are emotional, thoughtful, or considerable, they may induce emotional or cognitive arousal in the pre-sleep period that is considered to be a cause of insomnia symptoms.[28-31] Thus, mobile phone use after lights out may be presumed to also influence the psychological factors that disturb sleep. From the above, it is considered that various mechanisms—physiologic, psychological and others—are involved in the influence on sleep of mobile phone use after lights out. The results of this study showed that both calling and sending text messages were associated with sleep, each independently from the other. This may be because the mechanisms that influence sleep may differ according to type of mobile phone use. However, few studies have examined the association between mobile phone use after lights out and sleep, and the mechanisms underlying this association remain to be elucidated. Future studies should reveal more information about these mechanisms.

There were some limitations to our study. First, since this was a cross-sectional survey, a causal relationship could not be determined. For example, it could be that adolescents with sleep problems had difficulties falling asleep; they therefore used mobile phones. If so, treatment for sleep disturbances may decrease the use of mobile phones after lights out. Moreover, the proof of these mechanisms is not enough because there are few studies that have evaluated the influence of physiologic and psychological mechanisms derived from adolescents' use of mobile phones after lights out. When examining a causal relationship, a longitudinal study such as a cohort study and a biologic study are required, and such a study will be required in the future. Second, due to large sample size, the significant results may not necessarily endorse a true effect in this study. The results of this study showed significant associations between the use of mobile phones after lights out and sleep disturbances, but the odds ratios are small (less than 1.5). Then, the significance disappeared for some dummy variables, and some showed reverse associations after controlling the effects of covariates. Therefore, the effect sizes should be considered with the interpretation of the results of this study. Third, there may have been a degree of reporting bias because we used a self-reporting method. However, several previous reports have found that self-reported data on sleep status are consistent with physiologic data to a certain degree.[32,33] Fourth, the questions included in our questionnaire did not encompass all of the factors that might cause sleep disturbances. For example, noise levels at night, the person or persons with whom a subject sleeps, and commuting time to school are factors that could affect a subject's sleep. However, we were unable to include this line of inquiry in the questionnaire because of space limitations, and these items must be examined in the future. Finally, although the sample size was large, the approximate 37% nonresponse rate may have been a potential bias factor because we had no information about the nonresponders.

In conclusion, our results suggest that, among Japanese adolescents, the use of mobile phones for calling and for sending text messages after lights out is associated with various forms of sleep disturbance. However, there were some limitations, such as small effect sizes, in this study. Moreover, causal relationship could not be determined. More studies that examine details of this association are necessary. Because mobile phone use is one of the most familiar or intimate lifestyle factors for adolescents, it should be noted as a lifestyle habit that requires attention when attempting to establish strategies for appropriate sleep hygiene among adolescents. In the future, sleep hygiene education for adolescents should caution against the use of mobile phones after lights out; on the other hand, the rates of mobile phone use after lights out may decrease after treatment for a sleep disturbance.

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## DISCLOSURE STATEMENT

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# Clarification of the factor structure of the 12-item General Health Questionnaire among Japanese adolescents and associated sleep status

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ABSTRACT

If the factors affecting the mental health status of adolescents and their association with sleep status could be clarified, this information would be helpful for formulating lifestyle and healthcare guidance for the promotion of healthy growth and the prevention of mental problems in these individuals. The purpose of this study was to clarify (1) the factor structure of the 12-item General Health Questionnaire (GHQ-12), and (2) the associations between the factors extracted from this questionnaire and lifestyle, in particular sleep status, by using a representative sample population of Japanese adolescents. One hundred three thousand sixty hundred fifty self-administered questionnaires were collected from students enrolled in junior high and high schools in Japan. Of these questionnaires, 99,668 were analyzed. Sleep duration, subjective sleep assessment, bedtime, and insomnia symptoms of these students over the past month were studied to investigate sleep status. The factor analyses yielded two factors: depression/anxiety and loss of positive emotion. Sleep duration of less than 7 h was found to be associated with both depression/anxiety and loss of positive emotion, whereas sleep duration of 8 h or more was associated only with loss of positive emotion. Subjective sleep assessment and insomnia symptoms were associated with both depression/anxiety and loss of positive emotion. It was demonstrated that two underlying factors of mental health status were associated with differences in sleep status. In order to improve the mental health status of adolescents, it is important to provide guidance about sleep and lifestyle habits according to the mental health status of the individual.


## 1. Introduction

Epidemiological studies conducted worldwide have shown that the mental health status of adolescents is strongly associated with habitual sleep patterns and insomnia symptoms (Marks and Monroe, 1976; Morrison et al., 1992; Gau and Soong, 1995; Manni et al., 1997; Liu and Zhou, 2002; Bailly et al., 2004; Kaneita et al., 2006, 2007).

We have previously studied the association between sleep problems and mental health status in 100,000 Japanese adolescents by using the 12-item General Health Questionnaire (GHQ-12). We observed a linear association between subjective sleep assessment and mental health status and a U-shaped association between sleep duration and mental health status, i.e., poor mental health status was associated with both short and long sleep durations (Kaneita et al., 2007).

The GHQ-12, which was used in our previous study, is an instrument that was developed for screening mental health problems. It employs only 12 questions, and can easily evaluate mental health status. Furthermore, as it is also known for its high reliability and validity, the GHQ-12 is now used worldwide (Goldberg et al., 1976; Iwata et al., 1988; Politi et al., 1994; Kilic et al., 1997; Graetz, 1991; Werneke et al., 2000; Doi and Minowa, 2003; French and Tait, 2004; Hu et al., 2007).

Previous factor analyses of the GHQ-12 have suggested that it is influenced by several latent factors of mental health status (Campbell et al., 2003; Doi and Minowa, 2003; Hu et al., 2007). Recent nationwide representative surveys conducted in Japan and the UK

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involving factor analysis of the GHQ-12 yielded a two-factor solution: one was depression/anxiety such as depression and stress and the other was a loss of positive emotion, such as not having played a useful part and not having enjoyed normal activities (Doi and Minowa, 2003; Hu et al., 2007).

However, to date, no study has analyzed the factor structure of the GHQ-12 by conducting a survey on a representative, large-sized sample of adolescents. Therefore, the sleep status and lifestyle associated with each factor have not been clarified. Such information could be important for understanding the factor structure of mental health measures for adolescents, who are in a developmental phase of life, and the factors that affect these measures. This study has the following three major objectives: (1) To clarify whether or not the factor structure of the GHQ-12 which was obtained from about 100,000 highly representative samples (high school and junior high school students) has the two-factor structure noted in the previous study (2) to clarify the associated sleep characteristics and lifestyle habits when multiple factors are obtained; and (3) to extract some of the factor items obtained and to clarify whether mental health performance can be evaluated by using a smaller number of items.

We consider that, by clarifying the above, we can create a more specific guidance on sleep/lifestyle habits against signs of deterioration in particular mental health performance, and can correctly understand the mental health performance by using a smaller number of questions on a questionnaire.

## 2. Methods

### 2.1. Subjects and sampling

We have previously conducted two cross-sectional nationwide surveys (in 1996 and 2000) on lifestyle habits such as alcohol drinking, smoking, eating, and sleeping among Japanese adolescents (Suzuki et al., 2000; Ohida et al., 2004; Osaki et al., 2006).

For the present study, of the 11,060 junior high schools and 4627 senior high schools registered in Japan in May 2003, 131 junior high schools (selection rate: 1.2%) and 109 senior high schools (selection rate: 1.9%) were sampled. A single-stage cluster sampling method was employed with the probability of sampling proportional to the number of current students. All the students enrolled in the sampled schools were the subjects of this study. The sample size was determined by referring to the response rates and confidence intervals based on variance of results, which were obtained from the two previous studies.

In the Japanese education system, children enter primary school at the age of 6 years and leave after 6 years of study. They then enter junior high school for 3 years of study, followed by a further 3 years of study at senior high school. Primary and junior high school education is compulsory. In this report, the first to the third years of junior high school are called the 7th to 9th grades, and the first to third years of senior high school are called the 10th to 12th grades.

### 2.2. Survey procedure

We sent a letter to the principal of each selected school asking for cooperation in our survey, along with the same number of questionnaires and envelopes as the number of students enrolled at the school. At each school that agreed to participate in our survey, each class teacher distributed the questionnaires among the students. To protect the privacy of respondents and to obtain as candid a response as possible from each, it was clearly stated on the questionnaire that completed questionnaires would not be seen by the teachers. After filling in the anonymous questionnaire, each student was asked to seal the questionnaire in the provided envelope with an adhesive flap. Delivery and collection of the questionnaire were entrusted to the teachers, who were instructed to follow the guidelines for conducting the survey. The teachers collected and sent the sealed envelopes back to the National Institute of Public Health without opening them. The survey period was from December 2004 to the end of January 2005. This survey was approved by the Ethics Committee of the National Institute of Public Health.

### 2.3. Measures

The major areas that were included in the questionnaire were (1) lifestyle, including drinking and smoking behavior, (2) sleep status, (3) mental health status, and (4) personal data.

The questions related to lifestyle were whether the student ate breakfast (daily/occasionally/never) and whether he/she participated in extracurricular activities (participating actively/participating but not actively/not participating). The question, "How many days did you smoke in the past one month?" was included in the questionnaire. If the response to this question was "One day or more," then the student was defined as "smoking." Similarly, the question, "How many days did you consume alcoholic beverages in the past one month?" was asked, and if the response was "One day or more," then the student was defined as "drinking alcohol." In Japan, no smoking or alcohol use is allowed for people under 20 years old. Therefore, the smoking and drinking rates among high school and junior high school students are very low. In our previous study using the same data, regarding the number of days on which they consumed alcohol during the 30 days prior to the questionnaire, 70.3% responded "0 days," while 16.5% responded "1 to 2 days," 8.4% responded "3 to 5 days," 1.8% responded "6 to 9 days," 2.1% responded "10 to 19 days," 0.5% responded "20 to 29 days," and 0.3% responded "everyday." As for smoking, 90.6% responded "0 days," while 1.7% responded "1 to 2 days," 1.1% responded "3 to 5 days," 0.5% responded "6 to 9 days," 0.9% responded "10 to 19 days," 1.1% responded "20 to 29 days," and 4.1% responded "everyday" (Kaneita et al., 2007). From these results, as for drinking/smoking, rather than dividing and analyzing the smoking/drinking rates of one day or more during one month into smaller categories, we considered it more appropriate to define a frequency of one day or more as "having smoking/drinking behavior" and a frequency of zero days as "not having such behavior".

Sleep status was addressed by the following questions about (a) sleep duration, (b) subjective sleep assessment, (c) time of going to bed, (d) difficulty initiating sleep, (e) difficulty maintaining sleep, and (f) early morning awakening experience during the previous month were embedded in the questionnaire: the choices are indicated in parentheses.

a) How many hours on average do you sleep at night? (Less than 5 h/5 h or more but less than 6 h/6 h or more but less than 7 h/7 h or more but less than 8 h/8 h or more but less than 9 h/9 h or more).
b) How do you assess the quality of your sleep? (Very good/good/bad/very bad).
c) What time is your bedtime on average? (Before 10 p.m./10 p.m. or after but before 11 p.m./11 p.m. or after but before midnight/midnight or after but before 1 a.m./1 a.m. or after but before 2 a.m./2 a.m. or after).
d) Do you have difficulty falling asleep at night? (Never/seldom/sometimes/often/always).
e) Do you wake up during the night after you have gone to sleep? (Never/seldom/sometimes/often/always).
f) Do you wake up too early in the morning and have difficulty getting back to sleep? (Never/seldom/sometimes/often/always).

The Japanese version of the 12-item General Health Questionnaire (GHQ-12) was used to evaluate mental health status (Goldberg et al., 1976; Doi and Minowa, 2003). The GHQ-12 is a widely used, self-administered questionnaire that was originally designed as a screening tool for mental illness. It assesses 12 symptoms of psychiatric disorders that have been experienced during the previous month. Every item on the GHQ-12 describes a symptom and has four possible responses: the two answers that indicate the absence of the symptom are given a score of 0, and the two that indicate the presence of the symptom receive a score of 1. The overall score on the scale will thus fall into a range of 0 to 12, and it follows that the higher the total score, the poorer the state of mental health. The GHQ-12 score was originally applied to adult populations and then subsequently used and validated for adolescents as well (Radovanović et al., 1983; D'Arcy and Siddique; 1984; Arakida et al., 2003).

The demographic variables derived from personal data were gender, grade, type of school (junior high school/senior high school), and intention to study at university (yes/no).

### 2.4. Statistical analyses

To describe the distribution of GHQ-12 scores among the subjects, means, medians and modes were calculated by gender and grade. Gender differences in the scores were examined by Mann–Whitney *U*-test. Kruskal–Wallis test was used to examine grade differences in the scores. It has already been confirmed by our previous study that the GHQ-12 data used in this study has good internal consistency. Cronbach $\alpha$ for the whole sample was 0.833 (0.837 for males, 0.822 for females; Kaneita et al., 2007). As a usual rule of thumb, a value >0.2 was the correlated coefficient of an item with the item-deleted total score regarding homogeneity of the scale (Nunally and Bernstein, 1994; Doi and Minowa, 2003).

The principal factor method was employed to examine the factor structure of the scale. The unrotated solution was determined, following by an oblique promax rotation as a correlated solution to optimize the properties of the sample data. The number of factors retained and rotated was determined on the basis of an eigenvalue of >1.00. A value of 0.3 was determined to be the minimum value for a salient factor; a criterion of $\geq 0.5$ was regarded as better. We then conducted confirmatory factor analysis (CFA) using the maximum likelihood estimation method. We used the goodness-of-fit index (GFI), the adjusted GFI (AGFI), the root-mean-square error of approximation (RMSEA) values, and the expected cross-validation index (ECVI) to compare models. It was confirmed that the model with the highest GFI and AGFI values and the lowest RMSEA and ECVI values is the most desirable. CFAs were performed using AMOS version 5 for Windows (SPSS, Inc., Chicago, Ill.) with the maximum likelihood method.

We calculated subscale scores by summing the scores for items that constituted each extracted factor. We then compared the score distributions between boys and girls. The significance of categorical data was analyzed using the $\chi^2$ test. Similarly, the associations between subscale scores and sleep status were examined.