Residential area deprivation predicts smoking habit independently of individual educational level and occupational social class. A cross sectional study in the Norfolk cohort of the European Investigation into Cancer (EPIC-Norfolk)


RESEARCH REPORT

Objectives: To investigate the independent association between individual and area based measures of socioeconomic status and cigarette smoking habit.

Design and setting: Cross sectional, population based study.

Participants and methods: 12 579 men and 15 132 women aged 39–79 years living in the general community participating in the EPIC-Norfolk Study in 1993–1997. The association between social class, educational status, Townsend residential deprivation level, and cigarette smoking status was examined.

Main outcome measures: Cigarette smoking status at baseline survey.

Results: Social class, educational level, and residential deprivation level independently related to cigarette smoking habit in both men and women. Multivariate age adjusted odds ratios for current smoking in men were 1.62 (95% CI 1.45 to 1.81) for manual compared with non-manual social class, 1.32 (95% CI 1.17 to 1.48) for those with educational level less than O level compared with those with O level qualifications or higher and 1.84 (95% CI 1.62 to 2.08) for high versus low area deprivation level. For women, the odds ratios for current smoking for manual social class were 1.14 (95% CI 1.03 to 1.27); 1.31 (95% CI 1.18 to 1.46) for low educational level and 1.68 (95% CI 1.49 to 1.90) for high residential deprivation respectively.

Conclusions: Residential deprivation level using the Townsend score, individual social class, and educational level all independently predict smoking habit in both men and women. Efforts to reduce cigarette smoking need to tackle not just individual but also area based factors. Understanding the specific factors in deprived areas that influence smoking habit may help inform preventive efforts.

Methods

The population study is based in general practices geographically located in the county of Norfolk and includes the city of Norwich as well as surrounding small towns and rural areas. The cohort was recruited between 1993–1997 as part of the Norfolk component of the European Prospective Investigation into Cancer (EPIC-Norfolk). Detailed descriptions of the recruitment and study methodology have been reported previously. Men and women aged between 39–79 years identified from collaborating general practice registers were invited by mail to participate. Altogether 30 445 participants completed a detailed health and lifestyle questionnaire that included questions on smoking and socioeconomic variables. Cigarette smoking status was derived from the questions “Have you ever smoked as much as one cigarette a day for as long as a year?” and “Do you smoke cigarettes now?” and “Have you ever smoked as much as one cigarette a day for as long as a year?” and “Do you smoke cigarettes now?” Participants were then categorised as “current smoker”, “former smoker”, or “never smoker”. Social class was classified according to the registrar general’s occupation based classification scheme. Social class I consists of professionals, social class II includes managerial and technical occupations, social class III is subdivided into non-manual skilled workers and manual skilled workers, social class IV consists of partly skilled workers, and social class V comprises unskilled manual workers. For men, social class was coded using their own occupation except when they were unemployed or retired in which case their partner’s social class was used. Unemployed...
The Townsend deprivation score was used to identify material deprivation and is calculated using a combination of four variables derived from the 1991 census.22 The variables used were percentage of economically active residents over 16 years old who are unemployed (a measure of a general lack of material resources and insecurity), percentage of households with no car (a proxy for current income), percentage of households not owner occupied (a proxy indicator of wealth), and percentage of households with more than one person per room (an indicator of material living conditions)—all at the enumeration district level (an enumeration district has an average of about 150 households). Each variable was then standardised by obtaining Z scores using the mean and standard deviation across the enumeration districts in England and Wales. The Townsend deprivation score at the enumeration district level is derived from the sum of the Z scores and is standardised by obtaining Z scores using the mean and standard deviation across the enumeration districts in England and Wales. The Townsend deprivation score at the enumeration district level (an enumeration district has an average of about 150 households). Each variable was then standardised by obtaining Z scores using the mean and standard deviation across the enumeration districts in England and Wales. The Townsend deprivation score was dichotomised with those with Z scores less than 0 in the reference category and higher than the average for England and Wales. The separate components of the Townsend deprivation score were dichotomised with those with Z scores less than 0 in the reference category and those with scores above 0 were categorised as “more deprived”. Educational level was categorised into “at least O level” (which includes O level, A level, and degree) and “no qualifications”. To compare the independent association between the three socioeconomic status indicators and cigarette smoking status, regression models were conducted including all three variables simultaneously with age. Occupational social class, educational level, and area based deprivation were modelled as categorical variables. A second model was constructed using occupational social class, educational level dichotomously, and the separate components of the Townsend deprivation score. The components of the Townsend deprivation score were dichotomised with those with Z scores less than 0 in the reference category. A score larger than 0 indicates deprivation (with regard to each component) higher than the average for England and Wales. The separate components of the Townsend deprivation score were included to determine whether any one of the components was important or if it was the effect of a combination of all the variables that made up the Townsend deprivation score. Age was included as a covariate in all the models. Logistic regression was used for cigarette smoking status as binary variables: current smokers compared with non-current (former and never) smokers, where current smoking habit was examined as the dependent variable, or never smokers compared with ever (former and current) smokers tabulated according to the three measures of socioeconomic status: social class, level of education, and deprivation level (based on Townsend deprivation index). The χ² test for trend was used with the p value of <0.05 for statistical significance.

The independent effect of area based measure of socioeconomic status on smoking status, adjusted for individual based measures (both social class and level of education) was investigated. The effect of educational level on smoking status adjusted for social class was also investigated. To enable cross-stratified analyses using all three indicators, we re-categorised the three socioeconomic status indicators as dichotomous variables. Occupational social class was categorised into non-manual and manual: social classes I, II, and III non-manual were classified as “non-manual”, while social classes III manual, IV, and V were classified as “manual”. For area based deprivation, participants with Townsend deprivation scores of <0 were categorised as “less deprived”, while those with scores above 0 were categorised as “more deprived”. Educational level was categorised into “at least O level” (which includes O level, A level, and degree) and “no qualifications”.

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smokers where never smoking was examined as the dependent variable.

RESULTS

From the total 30,445 who completed the questionnaires, 2024 were excluded because of missing Townsend deprivation scores. Data on occupational social class were missing for 612 participants and 96 participants had their social class coded as unclassified while two people had missing values for level of education. These people were also excluded. The present analyses are therefore based on 12,579 men and 15,132 women. Table 1 shows the baseline characteristics for cigarette smoking status and distribution of participants according to the socioeconomic indicators (occupational social class, level of education, and Townsend deprivation index).

Cross tabulations of deprivation quintiles with social class and educational level as dichotomous variables for cigarette smoking status are shown in table 2. Men and women in manual social classes were more likely to be current smokers compared with those in non-manual social classes. Similarly, men and women with at least O level qualifications were less likely to be current smokers than those without qualifications.

Even after stratifying for social class or educational level, the influence of area based deprivation on smoking status was evident for both men and women, with a general trend of increasing proportions of current smokers with increasing residential deprivation quintiles (table 2A). Similar patterns in the reverse direction were apparent for never smokers (table 2B), that is the prevalence of never smokers was highest in men and women living in the least deprived areas.

In multivariate models adjusting for age, independent effects of social class, educational level, and residential deprivation level on cigarette smoking habit were observed in both men and women. Tables 3A and 3B show age adjusted odds ratios for social class, educational status, and Townsend deprivation quintile when all these were entered simultaneously in the model. In a logistic regression model that examined these variables dichotomously (not tabulated), age adjusted odds ratios for current smoking in men were 1.62 (95% CI 1.45 to 1.81) for manual compared with non-manual social class, 1.32 (95% CI 1.17 to 1.48) for those with educational level less than O level compared with those with O level qualifications or higher and 1.84 (95% CI 1.62 to 2.08) for high versus low area deprivation level. For women, the odds ratios for current smoking for manual social class were 1.14 (95% CI 1.03 to

Table 2A  Proportion of current smokers by deprivation category and social class and educational level for men (n=12579) and women (n=15132) aged 39–79 years, of the EPIC-Norfolk cohort, 1993–1997

<table>
<thead>
<tr>
<th>Townsend quintiles</th>
<th>Total %n</th>
<th>Total %n</th>
<th>Total %n</th>
<th>Total %n</th>
<th>Total %n</th>
<th>p value for trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current smokers</td>
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<tr>
<td>Men</td>
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<tr>
<td>By social class</td>
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</tr>
<tr>
<td>Non-manual</td>
<td>8.0 132</td>
<td>8.8 144</td>
<td>11.0 149</td>
<td>9.7 132</td>
<td>12.9 138</td>
<td>9.8 695 &lt;0.001</td>
</tr>
<tr>
<td>Manual</td>
<td>14.4 130</td>
<td>12.5 124</td>
<td>15.2 155</td>
<td>15.1 171</td>
<td>23.7 330</td>
<td>16.7 910 &lt;0.001</td>
</tr>
<tr>
<td>By educational level</td>
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<tr>
<td>At least O level</td>
<td>9.2 175</td>
<td>9.0 172</td>
<td>12.2 200</td>
<td>11.4 188</td>
<td>17.6 254</td>
<td>11.6 989 &lt;0.001</td>
</tr>
<tr>
<td>No qualifications</td>
<td>13.4 87</td>
<td>13.5 96</td>
<td>14.1 104</td>
<td>13.5 115</td>
<td>21.1 214</td>
<td>15.5 616 &lt;0.001</td>
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<tr>
<td>Women</td>
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<tr>
<td>By social class</td>
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</tr>
<tr>
<td>Non-manual</td>
<td>8.9 180</td>
<td>10.1 198</td>
<td>10.3 177</td>
<td>11.2 199</td>
<td>14.1 214</td>
<td>10.8 968 &lt;0.001</td>
</tr>
<tr>
<td>Manual</td>
<td>9.9 97</td>
<td>11.5 128</td>
<td>12.6 141</td>
<td>13.3 168</td>
<td>18.0 275</td>
<td>13.5 809 &lt;0.001</td>
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<td>By educational level</td>
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</tr>
<tr>
<td>At least O level</td>
<td>9.2 152</td>
<td>9.9 168</td>
<td>10.6 159</td>
<td>12.3 189</td>
<td>13.8 174</td>
<td>11.0 842 &lt;0.001</td>
</tr>
<tr>
<td>No qualifications</td>
<td>9.4 125</td>
<td>11.4 158</td>
<td>12.0 159</td>
<td>11.9 178</td>
<td>17.7 315</td>
<td>12.8 935 &lt;0.001</td>
</tr>
</tbody>
</table>

‡χ² test for trend.

Table 2B  Proportion of never smokers by deprivation category and social class and educational level for men (n=12579) and women (n=15132) aged 39–79 years, of the EPIC-Norfolk cohort, 1993–1997

<table>
<thead>
<tr>
<th>Townsend quintiles</th>
<th>Total %n</th>
<th>Total %n</th>
<th>Total %n</th>
<th>Total %n</th>
<th>Total %n</th>
<th>p value for trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never smokers</td>
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<tr>
<td>Men</td>
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<tr>
<td>By social class</td>
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</tr>
<tr>
<td>Non-manual</td>
<td>41.4 682</td>
<td>37.7 614</td>
<td>36.9 499</td>
<td>35.2 480</td>
<td>32.8 352</td>
<td>37.2 2627 &lt;0.001</td>
</tr>
<tr>
<td>Manual</td>
<td>33.1 299</td>
<td>29.7 295</td>
<td>30.8 313</td>
<td>25.4 287</td>
<td>20.4 284</td>
<td>27.2 1478 &lt;0.001</td>
</tr>
<tr>
<td>By educational level</td>
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</tr>
<tr>
<td>At least O level</td>
<td>40.9 778</td>
<td>37.8 721</td>
<td>37.7 617</td>
<td>33.2 546</td>
<td>30.5 441</td>
<td>36.3 3103 &lt;0.001</td>
</tr>
<tr>
<td>No qualifications</td>
<td>31.3 203</td>
<td>26.4 188</td>
<td>26.5 195</td>
<td>25.9 221</td>
<td>19.2 195</td>
<td>25.3 1002 &lt;0.001</td>
</tr>
<tr>
<td>Women</td>
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<tr>
<td>By social class</td>
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</tr>
<tr>
<td>Non-manual</td>
<td>60.1 1210</td>
<td>57.9 1138</td>
<td>59.3 1017</td>
<td>54.9 976</td>
<td>50.4 764</td>
<td>56.8 5105 &lt;0.001</td>
</tr>
<tr>
<td>Manual</td>
<td>59.8 588</td>
<td>54.8 611</td>
<td>55.2 618</td>
<td>55.8 702</td>
<td>50.7 774</td>
<td>54.9 3293 &lt;0.001</td>
</tr>
<tr>
<td>By educational level</td>
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<tr>
<td>At least O level</td>
<td>59.4 986</td>
<td>59.3 1007</td>
<td>60.5 911</td>
<td>55.1 849</td>
<td>52.2 660</td>
<td>57.5 4413 &lt;0.001</td>
</tr>
<tr>
<td>No qualifications</td>
<td>50.8 812</td>
<td>53.8 742</td>
<td>54.5 724</td>
<td>55.5 829</td>
<td>49.4 878</td>
<td>54.5 3985 &lt;0.001</td>
</tr>
</tbody>
</table>

‡χ² test for trend.
The independent odds ratios for never smokers in men were 0.69 (95% CI 0.64 to 0.75) for manual compared with non-manual social class, 0.78 (95% CI 0.71 to 0.85) for those with educational level less than O level compared with those with O level qualifications or higher and 0.70 (95% CI 0.63 to 0.78) for high versus low area based deprivation. The odds of never smoking were 0.97 (95% CI 0.91 to 1.04) for women in manual compared with non-manual social class, 0.91 (95% CI 0.85 to 0.98) for those with low educational level versus high educational level and 0.76 (95% CI 0.70 to 0.83) for those with high area based deprivation. Low residential deprivation area was thus also predictive of never smoking in both men and women, with an effect size in women greater than personal social class and educational level.

The inclusion of individual components of the Townsend deprivation index in the second model did not have any effect on the influence of social class and educational level on being a current smoker (table 4A). In both men and women, those who lived in areas where there is a high percentage of unemployment and households with no car were more likely to be current smokers. Men who lived in areas where there is a higher percentage of unemployment, households with no car, and households not owner occupied were less likely to be
never smokers (Table 4B). However, the effect size was smaller compared with social class and educational attainment. In women, unemployment and lack of car significantly predicted a never smoker with those living in areas of higher unemployment and households with no car less likely to be a never smoker. The strength of association was greater for unemployment and lack of car compared with social class and educational level.

**DISCUSSION**

Many studies have investigated the effects of socioeconomic status on health. Most of the studies used single indicators of socioeconomic status such as occupational social class, educational level, or area based measures such as deprivation indices, often with the area based measure used as a surrogate measure for individual social class where this was not available. A few studies that examined the association between individual and area based measures of socioeconomic status on all cause mortality, self reported health, and cardiovascular disease risk factors found independent effects of area deprivation after controlling for individual based measures of socioeconomic status. How exactly socioeconomic status affects health outcomes is not well understood but at least some of the effect is thought to be mediated through differences in lifestyles such as diet or cigarette smoking habit.

In this study we found strong independent effects of individual social class, educational status, and residential area deprivation on cigarette smoking habit. The independent effect of residential area deprivation was comparable to that of individual measures of social class and educational status.

It is unlikely that this effect could be explained by selection biases or confounding. The EPIC-Norfolk study was designed as a prospective study so the aim was to recruit a cohort willing to participate in the baseline survey and to be followed up. Though the response rate was about half those mailed and characteristics of participants were somewhat skewed to the type of persons willing to participate in such studies, as evident from the tables, there was still a wide range of social class, educational status, and residential area deprivation within the cohort. Thus, while the prevalence distribution of social class and deprivation might not be exactly representative of national samples, this would not bias the within cohort relations between smoking and socioeconomic status. In fact, the distribution of social class was not dissimilar to that reported in national surveys. While deprivation based on the mean Townsend score seems to be shifted in a favourable direction in this cohort, the Townsend score uses indices such as car ownership and overcrowded housing, which may be more appropriate for urban environments and may not be sensitive to rural deprivation such as that which occurs in Norfolk. The study design is thus unlikely to produce substantial biases in the relation between socioeconomic status and smoking within the population. The exclusion of people whose social class and deprivation scores were missing or not classified could cause bias only if they differed from those included in the study with respect to the relation between social class and smoking or area based deprivation and smoking, which seems unlikely.

It is also possible that persons of different socioeconomic status or education may report smoking habits differently. However, it is not likely that a person’s residential postcode could influence their self reports of smoking habit. In any

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**Table 4A** Odds ratio (95% confidence intervals) for current smokers in 12579 men and 15132 women aged 39–79 years, of the EPIC-Norfolk cohort, 1993–1997 for models based on age, social class, level of education, and components of Townsend deprivation index

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Current smokers</th>
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<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>p value</td>
<td>OR*</td>
<td>p value</td>
</tr>
<tr>
<td>Social class (non-manual† v manual)</td>
<td>1.61 (1.43 to 1.80)</td>
<td>&lt;0.001</td>
<td>1.13 (1.02 to 1.26)</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Education (at least O level† v no qualifications)</td>
<td>1.30 (1.16 to 1.47)</td>
<td>&lt;0.001</td>
<td>1.30 (1.17 to 1.45)</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Unemployment‡</td>
<td>1.26 (1.04 to 1.52)</td>
<td>0.02</td>
<td>1.33 (1.11 to 1.60)</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Households with no car‡</td>
<td>1.50 (1.28 to 1.77)</td>
<td>&lt;0.001</td>
<td>1.32 (1.13 to 1.55)</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Households not owner occupied‡</td>
<td>1.14 (1.01 to 1.28)</td>
<td>0.04</td>
<td>1.14 (1.02 to 1.28)</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Overcrowding‡</td>
<td>1.10 (0.93 to 1.29)</td>
<td>0.26</td>
<td>1.10 (0.94 to 1.28)</td>
<td>0.26</td>
<td></td>
</tr>
</tbody>
</table>

*Odds ratio indicates change in probability compared with the reference category. †Reference category. Predictor variables: social class—non-manual=social classes I, II, and III non-manual, manual=social classes III manual, IV, and V. Education—at least O level, no qualifications. ‡Reference category—areas with Z score below the average for England and Wales average (<0).

**Table 4B** Odds ratio (95% confidence intervals) for never smokers in 12579 men and 15132 women aged 39–79 years, of the EPIC-Norfolk cohort, 1993–1997 for models based on age, social class, level of education and components of Townsend deprivation index

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Never smokers</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>p value</td>
<td>OR*</td>
<td>p value</td>
</tr>
<tr>
<td>Social class (non-manual† v manual)</td>
<td>0.70 (0.64 to 0.76)</td>
<td>&lt;0.001</td>
<td>0.98 (0.91 to 1.05)</td>
<td>0.51</td>
<td></td>
</tr>
<tr>
<td>Education (at least O level† v no qualifications)</td>
<td>0.79 (0.72 to 0.86)</td>
<td>&lt;0.001</td>
<td>0.92 (0.85 to 0.98)</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Unemployment‡</td>
<td>0.81 (0.68 to 0.95)</td>
<td>0.01</td>
<td>0.79 (0.69 to 0.90)</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Households with no car‡</td>
<td>0.85 (0.74 to 0.97)</td>
<td>0.02</td>
<td>0.89 (0.80 to 0.99)</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Households not owner occupied‡</td>
<td>0.84 (0.77 to 0.92)</td>
<td>&lt;0.001</td>
<td>0.96 (0.89 to 1.03)</td>
<td>0.26</td>
<td></td>
</tr>
<tr>
<td>Overcrowding‡</td>
<td>0.92 (0.81 to 1.05)</td>
<td>0.23</td>
<td>0.90 (0.81 to 1.01)</td>
<td>0.06</td>
<td></td>
</tr>
</tbody>
</table>

*Odds ratio indicates change in probability compared with the reference category. †Reference category. Predictor variables: social class—non-manual=social classes I, II, and III non-manual, manual=social classes III manual, IV, and V. Education—at least O level, no qualifications. ‡Reference category—areas with Z score below the average for England and Wales average (<0).
Key points

- Efforts to stop smoking have traditionally focused on individually based interventions such as psychological therapies, or national approaches such as taxation and advertising.
- In men and women in the general population, residential area deprivation, social class, and educational status all independently predicted smoking habit.
- Residential area deprivation was a strong independent predictor with those living in more deprived areas having one and a half to twice the likelihood of being a current smoker compared with less deprived areas. This effect was comparable to that observed for social class and educational status.
- This may point to more effective local strategies for smoking cessation.

... the physical environment of the area may play a part in promoting the uptake of smoking. The quality of housing and overcrowding may lead to increasing level of stress and as a result, people turn to smoking as a form of stress reliever. This, coupled with the differential availability of cigarettes may explain the higher prevalence of smoking in deprived areas. The pathways linking education and health have been discussed previously. One of the possible pathways entails the role of education in improving health related knowledge, which in turn influences individuals to adopt healthier lifestyles. However, when examining the association between education and cigarette smoking, Kenkel found that the influence of education on smoking remains, even after health related knowledge was taken into account. This suggests that there are effects beyond health related knowledge that are involved. This may include differential cultural values.

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Contributors

KTK, ND, SB, and NW are principal investigators in the EPIC-Norfolk population study. SO was study coordinator and organised data collection with AW. RL is responsible for data management and computing and data linkages for post coding and assisted with analyses. SS conducted the data analyses and wrote the paper with KTK with contributions from other coauthors. KTK is guarantor for this paper.

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Competing interests: none declared.

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Residential area deprivation predicts smoking habit independently of individual educational level and occupational social class. A cross sectional study in the Norfolk cohort of the European Investigation into Cancer (EPIC-Norfolk)


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