The cost effectiveness of telephone counselling to aid smoking cessation in Denmark: A modelling study

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Abstract
Aim: To assess the cost-effectiveness of the Danish smoking cessation telephone service “quitline”. Methods: The study was based on the number of quitline callers in 2005. The outcome was measured as costs per life year saved (LYS) based on the assessment in 2001 of continued abstinence over a 12-month period (19.0%) and point prevalence of abstinence at 12 months of follow up (29.7%), respectively. The costs per LYS are estimated as the annual running costs of reactive telephone counselling service divided by the total number of LYS, which has been estimated as the difference between current smokers’ and ex-smokers’ life expectancies according to age group and gender based on Danish smoking proportions, relative risks of smoking-related mortality of all causes, and standard life tables. Results: A total of 511 ex-smokers have been estimated to gain 2172 life years based on continued abstinence over 12 months. Using the point prevalence abstinence at 12 months, 799 ex-smokers are estimated to gain 3394 life years. Discounting LYS at 3% p.a., the costs per LYS are €213 for ex-smokers with continued abstinence and €137 for ex-smokers with point prevalence abstinence. The sensitivity analysis for a worst-case scenario indicates that the costs per LYS are €1199. For comparison the average costs per LYS of smoking cessation interventions in other Danish settings are €1592 (95% CI €1547-1636). Conclusions: The Danish reactive telephone counselling to aid smoking cessation appears to be cost-effective in comparison with other Danish smoking cessation interventions.

Key Words: Research support, non-US Government, cost-benefit analysis, counselling, Denmark, female, hotlines/economics, humans, male, smoking cessation, treatment outcome

Background
Tobacco smoking is an important cause of premature death and morbidity, up to half of all lifetime smokers will ultimately die of a disease caused by smoking [1,2]. Despite decreases in the last decades in the proportion of current smokers in Denmark and other industrialised countries [3,4], smoking remains the single largest preventable cause of death and disease [1,5]. Several studies have shown that smoking cessation has health benefits for people of all ages [6]. A Cochrane review and a meta-analysis find that proactive telephone counselling of smokers – with call back to people who have initiated the contact with the quitline – is effective [7,8]. Reactive telephone counselling – with immediate response to smokers, who call to ask for assistance – may also lead to improved outcomes [9]. However, there are only a few European quitlines that have been evaluated for their cost-effectiveness, and as far as known, the only assessment of the cost-effectiveness of reactive telephone counselling of smokers in terms of the costs per life year saved (LYS), has been performed in Sweden. This Swedish study was based on point prevalence abstinence at 12 months and not on continued abstinence [10].

The Danish quitline was established in 1999 as a nationwide free-of-charge service for the callers. In 2005, it was operating 29 hours a week (Monday to Friday). Seven telephone lines were available, with on average three in operation at any given time. The quitline is operated by the National Board of Health.

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Aims

The primary purpose of this study was to assess the cost-effectiveness of the Danish reactive telephone counselling. This is done by first estimating the costs and LYS based on continued abstinence from smoking over 12 months, and secondly comparing cost per LYS to other smoking cessation interventions.

Materials and methods

The perspective is on the running costs of the Danish quitline per year in relation to available data about LYS for those who quit smoking and to the annual number of quitters, respectively. The estimations are based on Danish data including the running costs of the quitline service, the annual number of telephone calls, and the proportions of smokers ceasing after contacting the quitline. LYS for ex-smokers are estimated by modelling Danish data.

No attempt was made to estimate the potential future costs savings for the health services due to the smokers ceasing to smoke. The reason for this is that the primary purpose of this study was to compare the cost-effectiveness of smoking cessation as a result of telephone counselling with that of other smoking cessation interventions.

Quitline callers and quitting proportion

The annual number of quitline callers is based on data from 2005: the quitline received 2758 calls from current smokers, who wanted counselling on smoking cessation. For those callers, age, gender, quantity of tobacco consumption per day, and years of smoking were recorded. The majority were females (57.4%) and their average age was 40.9 years. More than 30% of the males and 13% of the females were younger than 25 years (Table I). On average they smoked the equivalent of 24 cigarettes per day and had smoked for 23.5 years [11]. Persons without records have subsequently been distributed proportionally by sex and age groups.

The initial sample of quitline callers comprised all 2758 persons in the source population. There were 723 registrations missing age or sex records. Persons without records have subsequently been distributed proportionally by sex and age groups.


Table I. Number of current smokers calling the quitline by age and gender: Denmark, 2005

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Males</th>
<th>Females</th>
<th>All</th>
<th>Males</th>
<th>Females</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤15</td>
<td>82</td>
<td>44</td>
<td>126</td>
<td>9.1</td>
<td>3.9</td>
<td>6.2</td>
</tr>
<tr>
<td>16–20</td>
<td>109</td>
<td>48</td>
<td>157</td>
<td>12.1</td>
<td>4.2</td>
<td>7.7</td>
</tr>
<tr>
<td>21–30</td>
<td>156</td>
<td>173</td>
<td>329</td>
<td>17.4</td>
<td>15.2</td>
<td>16.2</td>
</tr>
<tr>
<td>31–50</td>
<td>316</td>
<td>448</td>
<td>764</td>
<td>35.2</td>
<td>39.4</td>
<td>37.5</td>
</tr>
<tr>
<td>51–66</td>
<td>176</td>
<td>345</td>
<td>521</td>
<td>19.6</td>
<td>30.4</td>
<td>25.6</td>
</tr>
<tr>
<td>≥67</td>
<td>60</td>
<td>78</td>
<td>138</td>
<td>6.7</td>
<td>6.9</td>
<td>6.8</td>
</tr>
<tr>
<td>Total</td>
<td>899</td>
<td>1136</td>
<td>2035</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Persons without records have subsequently been distributed proportionally by age groups.

Source: Report of documentation for the quitline in 2004 [12].

Table II. Number of responding quitline callers and self-reported point prevalence abstinence at 12-month follow up by age group: 2001

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Responding quitline callers</th>
<th>Point prevalence abstinence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>14–25</td>
<td>17</td>
<td>5.7</td>
</tr>
<tr>
<td>26–40</td>
<td>103</td>
<td>34.8</td>
</tr>
<tr>
<td>41–60</td>
<td>127</td>
<td>42.9</td>
</tr>
<tr>
<td>61–78</td>
<td>40</td>
<td>13.5</td>
</tr>
<tr>
<td>Missing age registrations</td>
<td>9</td>
<td>3.0</td>
</tr>
<tr>
<td>Total</td>
<td>296</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Costs of reactive telephone counselling

The cost estimates are based on the running costs of the quitline service in 2005 except for costs of proactive counselling (including call-backs from the counsellors), and of research. The consumer price index is used to adjust all costs from 2005 prices to 2009 prices [13] and for conversion from DKK to €, the exchange rate of DKK 744.53 per €100 is used [14]. The total running costs of reactive counselling on smoking cessation amount to €184,820 per year, including payroll costs, rent of premises, telephone subscription, and costs of administration and education of the counsellors.
Life expectancy and LYS

Life expectancies are estimated as the cumulative survival probabilities (truncated at age 89), conditional on being alive at given ages (35, 40, ...., 75) by gender for current moderate smokers (consuming 15−24 g tobacco per day − equivalent to 15−24 cigarettes per day) and for former moderate smokers. The estimations are based on Danish age- and gender-specific smoking proportions [15], Danish age- and gender-specific relative risks of smoking-related mortality of all causes (<65 years and ≥65 years) according to smoking status [16], and standard life tables from Statistics Denmark [17]. The algorithms are estimated as described in detail in another Danish study [18]. Subsequently, the LYS are estimated as the gender-specific difference between current and former moderate smokers’ life expectancy at given ages (35−39 years and 40−44, 45−49, 50−54, 55−59, 60−64, 65−69, 70−74, 75−79). For the estimation of LYS for younger ages (30, 25, 20), linear extrapolation is used, assuming that LYS for 15-year-old quitters are zero. From Table III it appears, for example, that for the age group of 35−39 years, the number of LYS for a former moderate smoker compared to a current moderate smoker is 7.4 years for males and 6.4 years for females.

Table III. Life expectancy for smokers and ex-smokers and life years saved for smokers quitting at different ages

<table>
<thead>
<tr>
<th>Life expectancy and life years saved (years)</th>
<th>Age (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>35−39</td>
</tr>
<tr>
<td>Males</td>
<td></td>
</tr>
<tr>
<td>Life expectancy, smokers</td>
<td>36.0</td>
</tr>
<tr>
<td>Life expectancy, ex-smokers</td>
<td>43.4</td>
</tr>
<tr>
<td>Life years saved for smokers</td>
<td>7.4</td>
</tr>
<tr>
<td>Females</td>
<td></td>
</tr>
<tr>
<td>Life expectancy, smokers</td>
<td>38.4</td>
</tr>
<tr>
<td>Life expectancy, ex-smokers</td>
<td>45.3</td>
</tr>
<tr>
<td>Life years saved for smokers</td>
<td>6.9</td>
</tr>
</tbody>
</table>

Smokers and ex-smokers based on consumption of 15−24 g tobacco per day.
Life years saved based on moderate smokers quitting at different ages: e.g. the life years saved are 7.4 years for a 35−39-year-old male smoker quitting at the same age.

Life expectancy and LYS

Life expectancies are estimated as the cumulative survival probabilities (truncated at age 89), conditional on being alive at given ages (35, 40, ...., 75) by gender for current moderate smokers (consuming 15−24 g tobacco per day − equivalent to 15−24 cigarettes per day) and for former moderate smokers. The estimations are based on Danish age- and gender-specific smoking proportions [15], Danish age- and gender-specific relative risks of smoking-related mortality of all causes (<65 years and ≥65 years) according to smoking status [16], and standard life tables from Statistics Denmark [17]. The algorithms are estimated as described in detail in another Danish study [18]. Subsequently, the LYS are estimated as the gender-specific difference between current and former moderate smokers’ life expectancy at given ages (35−39 years and 40−44, 45−49, 50−54, 55−59, 60−64, 65−69, 70−74, 75−79). For the estimation of LYS for younger ages (30, 25, 20), linear extrapolation is used, assuming that LYS for 15-year-old quitters are zero. From Table III it appears, for example, that for the age group of 35−39 years, the number of LYS for a former moderate smoker compared to a current moderate smoker is 7.4 years for males and 6.4 years for females.

The estimations of the cessation frequencies are based on two assumptions: (i) PPA12 is equally distributed within each of the age groups presented in Table II; and (ii) 64% of all point prevalent quitters, regardless of age and gender, are continuously abstinent throughout the 12-month period.

Cost-effectiveness

The costs per LYS are estimated as the annual running costs for the reactive telephone counselling service divided by the sum of the estimated LYS for males and females in all age groups. Thus, for 35−39-year-old males the LYS is estimated by multiplying the number of 35−39-year-old male quitline callers receiving reactive telephone counselling by the proportion ceasing to smoke as a consequence of the reactive telephone counselling, and by the LYS for males in this specific age group.

The choice of discount rate has a great impact upon costs per LYS in studies of economics of prevention. In the present study the costs are not discounted as they were incurred during 1 year. By contrast, the LYSs are discounted with a rate of 3% p.a. for the base analysis [19].

Sensitivity analyses

In this study, data from a number of different sources have been used. The robustness of the results, therefore, may be examined in one-way sensitivity analyses and also combined in a multivariate sensitivity analysis to determine whether the results will change significantly [20].

Thus, the cost-effectiveness ratios are recalculated by: (i) reducing the number of LYS (two analyses are done: the expected lifetime of <35-year-old smokers does not increase by smoking cessation [21], respectively, the estimated LYS are halved; (ii) reducing the quit rate (again, two analyses: the quit rate is reduced with six percentage points according to findings in a Danish study, where 6% of the smokers quit without help [22], respectively, only 50% of the smokers quit smoking persistently as a consequence of the counselling (a rather conservative estimate); the lifetime risk of relapse after not having smoked for 12 months was assumed to be 10% in the study, which I subsequently compare with Olsen et al. [23]); (iii) increasing the costs by 20% (costs are relatively certain, as they are based on the annual account); and (iv) varying the discount rate for LYS (0 and 5% p.a.) [19].
Results

In Table IV, the accumulated LYS is presented by age, gender, and discount rate. A total of 511 ex-smokers are expected to have gained 866 years (351 years for males and 515 years for females), when the estimates are based on CA12 and discounted at 3% p.a. LYS increases to 2172 years (859 years for males and 1313 years for females), when they are undiscounted and decreases to 374 years (185 years for males and 189 years for females) at 5% discounting, respectively. Using PPA12 there will be 799 quitters annually. This number of ex-smokers is expected to gain 1353 years (3394 undiscounted life years and 585 years, when discounted with 5% p.a.).

In Table V, the costs per LYS of reactive telephone consulting are shown for each analysis. In the base analysis, the costs per LYS are €213 for ex-smokers with CA12 and €137 for ex-smokers with PPA12, respectively. In the worst-case scenario (no gain in life expectancy for smokers quitting before the age of 35 years, the expected LYS and the number of ex-smokers is halved, and the costs are increased by 20%) the costs per LYS (still discounted at 3% p.a.) are increased to €1199 for those who are CA12 and to €768 for those who are PPA12, respectively. The costs per quitter at the follow up are €362 based on CA12 whereas they are €231 for PPA12.

Discussion

To the best of my knowledge, this is the first published study evaluating the costs per LYS of reactive telephone counselling on smoking cessation based on CA12. The costs per LYS of the Danish quitline are €213 for ex-smokers with CA12, based on PPA12 they are €137. However, the analyses (3a and 3b) based on an approach compensating for the
spontaneous quit rate may be more realistic: €268 per LYS for CA12 and €171 per LYS for PPA12, respectively. These results are in good accordance with the costs per LYS of Swedish reactive telephone counselling: USD311−401 (2002 prices) equivalent to €311−401 in 2009 prices [10]. For further comparison, the average costs per LYS of smoking cessation interventions in other Danish settings are €1592 (in 2009 prices). Males, light smokers and participant at hospitals seems to have 15% lower cost-effectiveness ratios versus the total sample including current smokers in different settings with hospitals, pharmacies, and county service [23]. The costs per LYS appears to be lower in the present study, even with assumptions made for a worst-case scenario: €1199 per LYS. However, the results should be interpreted with caution.

This study is based on data collected from an ongoing intervention as opposed to a randomised clinical study, and the results are subject to at least four limitations. First, the definition of CA12 and PPA12, does not guarantee life-long abstinence, although widely used. Second, it may be argued that the quitline callers were more motivated for ceasing than smokers in other settings. This may be the explanation for lower cost-effectiveness ratios in the present study compared to the results from the other Danish study [23]. Third, comparisons of the effect of smoking cessation interventions must proceed cautiously, because smokers seeking advice are not homogeneous and react differently to specific interventions and depending on the context. Thus, it appears that males, older persons, persons with low nicotine dependence, participants in group-based smoking cessation interventions, and participants in smoking cessation interventions in pharmacies are obviously most likely to stay abstinent for 12 months [24]. In this study the abstinence was not biochemically validated, but the Third National Health and Nutrition Examination Survey has concluded that self-reported smoking status among adults is reliable [25], and the Danish proportion of PPA12 (29.7%) was similar to the results in the Swedish study (31%) [10]. However, the proportion of CA12 (19%) was a little higher than the overall proportion of CA12 in Danish smoking interventions implemented by pharmacies, hospitals, municipalities, and other public or private bodies (16%) [24]. Assuming quitline callers without follow-up data have relapsed, the CA12 was reduced to 15%. Fourth, LYS was based on smoking-related mortality data published back in 1998 [16]. Though, the magnitude of the relationship
between smoking and the diseases it causes has remained stable over time [1], the relative risks associated with smoking were based on deaths among birth cohorts who might have had different smoking histories than current smokers in this study (e.g., age of initiation and duration of smoking before quitting). It is, however, not essential for the assessment of cost-effectiveness, as the other Danish study [23] has used the same mortality data for their estimations of LYS.

LYS is used as an endpoint. However, smoking cessation also leads to future benefits in terms of longer lifetime in good health [26], which is not included in the assessment of this study. Consequently, the effectiveness of the quitline may be underestimated. From a Danish study it appears that the lifetime health cost saving of smoking cessation for a 35-year-old moderate smoker amounts to almost €31,000 for men and slightly more for women (2009 prices). A little less than half (45%) of this cost saving is due to reduced direct health care costs, while the rest is a measure of the reduction in productivity costs associated with an increased life expectancy and diminution of illness episodes during the productive life of the former smokers [18,27]. Though the results of this study are relatively conservatively estimated it should be made clear that attracting more heavy and nicotine dependent smokers to reactive telephone counselling probably will induce increasing costs and reduce the quitting rate, which may lead to an increase of the costs per LYS. Likewise, if relatively more smokers with smoking-related morbidity that eventually will cause smoking-related mortality are attracted, the cost per LYS may increase due to lower LYS.

Conclusions

Reactive telephone counselling on smoking cessation appears to be cost-effective in comparison with other Danish smoking cessation interventions.

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Conflict of interest

None declared.

References


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