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Original Investigation

Trends in Individualized Affordability of Factory-Made Cigarettes: Findings of the 2008–2020 International Tobacco Control Netherlands Surveys

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Abstract

Introduction: Cigarette affordability, the price of tobacco relative to consumer income, is a key determinant of tobacco consumption.

Aims and Methods: This study examined trends over 12 years in individualized factory-made cigarette affordability in the Netherlands, and whether these trends differed by sex, age, and education. Data from 10 waves (2008–2020) of the International Tobacco Control Netherlands Surveys were used to estimate individualized affordability, measured as the percentage of income required to buy 100 cigarette packs (Relative Income Price [RIP]), using self-reported prices and income. The higher the RIP, the less affordable cigarettes are. Generalized estimating equation regression models assessed trends in individualized affordability over time and by sex, age, and education.

Results: Affordability decreased significantly between 2008 and 2020, with RIP increasing from 1.89% (2008) to 2.64% (2020) ($p \leq .001$), except for 2008–2010, no significant year-on-year changes in affordability were found. Lower affordability was found among subgroups who have a lower income level: Females (vs. males), 18–24 and 25–39-year-olds (vs. 55 years and over) and low or moderate-educated individuals (vs. highly educated). Interactions between wave and education ($p = .007$) were found, but not with sex ($p = .653$) or age ($p = .295$). A decreasing linear trend in affordability was found for moderately ($p = .041$) and high-educated ($p = .025$), but not for low-educated individuals ($p = .149$).

Conclusions: Cigarettes in the Netherlands have become less affordable between 2008 and 2020, yet this was mostly because of the decrease in affordability between 2008 and 2010. There is a need for more significant increases in tax to further decrease affordability.

Implications: Our findings suggest that cigarettes have become less affordable in the Netherlands between 2008 and 2020. But, this appears to be the result of a steep decrease in affordability between 2008 and 2010. Affordability was lower among groups who have on average lower incomes (females, young adults, and low- and moderate-educated individuals), and differences in trends across education levels could be explained by per capita income changes. Our individualized measure indicated lower affordability than published aggregate affordability estimations. Future tax increases should be large enough to result in a lower affordability.

Introduction

Tobacco taxation is the single most effective tobacco control policy.[1,2] Raising prices encourages smokers to quit smoking, reduce consumption, and discourage smoking initiation.[3] Research has shown that the greater the tax—and thus price—increase, the greater the reduction in tobacco consumption is.[4] However, taxation as a tobacco control measure should not be considered in isolation. Rapid economic growth and changing inflation rates can offset a price increase, even resulting in a more affordable product relative to a person's income.

Affordability is commonly defined as the price of a product, relative to the income of a consumer.[5] The two most used standardized approaches to calculate cigarette affordability are Van Walbeek & Blecher's Relative Income Price (RIP)[5] and Guindon's Minutes of Labor.[6] The RIP calculates the percentage of per capita Gross Domestic Product needed to purchase 100 packs of cigarettes, usually Marlboro or an equivalent. Higher RIP scores indicate that cigarettes are less affordable. The Minutes of Labor measures how long an individual needs to work to purchase a pack of cigarettes,

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based on the net hourly wage of 12 occupations. While both methods are closely correlated—especially for high-income countries—the RIP is more commonly used.[3,7] The drawback of both methods is that they rely on average or standardized measures, which do not properly account for the range of incomes as well as the range of prices paid within a country. Smoking is becoming more concentrated in disadvantaged—often lower income—groups in society, because of slower declines in prevalence.[8–11] For example, In 2020, prevalence of smoking was almost 10 percentage points higher among low- or moderately educated citizens than among high-educated smokers in the Netherlands.[12] Using individualized measures can provide a more accurate estimation of affordability than national-level measures, which might overestimate income and thus affordability among the lower-income smoker population. In addition, one standardized measure of tobacco price does not account for the price variability across tobacco products or consumers' use of price-minimizing strategies.

A solution to these shortcomings is to use individual-level data, rather than average or standardized measures. Studies from the International Tobacco Control (ITC) Policy Evaluation Project in China,[13] and Bangladesh[14] used a modified version of the RIP based on individual-level data, such as reported income and price of their current pack of cigarettes. This gives better insight into the financial burden of smoking, both for the smoking population and across subgroups, and can help design future policies to deliver more equitable outcomes.

In this paper, we explore the trends in individualized affordability of factory-made (FM) cigarettes among daily smokers in the Netherlands between 2008 and 2020. Between 2008 and 2020, the weighted average price increased from €5.24 to €6.69 for a pack of 20 cigarettes (inflation-adjusted).[15] Prices increased annually, and more steeply from 2018 onwards. In 2018, the Netherlands government announced annual tax increases, aiming to achieve an average price of 10 euros per pack of 20 cigarettes in 2023. In 2020, a pack of Marlboro cost €8, after taxes increased to €1 per pack of cigarettes.[16] Additionally, we explored whether trends in affordability differed among sex, age, and education groups.

Methods

Sample

This study used data from the ITC Policy Evaluation Netherlands Surveys, a population-based longitudinal cohort survey among a nationally representative sample of smokers. The first ITC Netherlands cohort was set up in 2008 and was conducted until 2017. In 2020, a new cohort was set up. ITC Netherlands participants were recruited from a probability-based web database administered by Kantar Public. Participants were eligible if they had smoked at least 100 cigarettes in their life, and were at least a monthly smoker at the time of recruitment. Respondents received "Nipoints," which can be used to acquire gift cards, as an incentive for participation. More information about sampling and weighting can be found elsewhere.[17]

The sample for the current study is daily FM cigarette smokers from the ITC Netherlands Surveys between 2008 and 2020. Respondents that indicated smoking both FM cigarettes and roll-your-own tobacco (n = 2218 observations), as well as respondents that indicated to exclusively smoking roll-your-own tobacco (n = 3425 observations), were excluded from analyses. Between 2008 and 2017, not enough information about roll-your-own tobacco purchases was collected to set up an accurate affordability measure. For example, pouch size was gathered through a verbal designation (small/standard/large) rather than per gram. There is, however, no consensus on how many grams a "standard" size pouch is. As a result, setting up an affordability measure for roll-your-own tobacco smokers would require many assumptions and careful interpretations. Finally, daily FM cigarette smokers who did not report their income (n = 1952 observations) were excluded since affordability is the ratio between income and price paid for tobacco, and thus could not be calculated without income. Supplementary Table 1 displays the group differences between the included and excluded respondents. Roll-your-own tobacco smokers differed from FM cigarette smokers on all characteristics: roll-your-own tobacco smokers were more likely male, over the age of 55 years, low- or moderately educated, had larger households, smoked more cigarettes per day, and smoked their first cigarette earlier than FM cigarette smokers. Individuals who smoked both FM cigarettes and roll-your-own tobacco were also more likely male, aged 40–54 years, low- or moderately educated, smoked more cigarettes per day, and were more likely to smoke their first cigarette within thirty minutes after waking up than exclusive FM cigarette smokers. Daily FM cigarette smokers who did not report their income were more likely female, aged 18–24 years, and low- or moderately educated than those who did report their income.

One survey wave per available calendar year was included. Sample size differed per wave, ranging from 369 (2017) to 708 (2020). The 2009 wave was excluded since only the Computer-Assisted Telephone Interviewing (CATI) respondents and not the Computer-Assisted Web Interviewing (CAWI) respondents were asked to provide data about their last purchase. As a result, the affordability measure was only able to be set up for a small subsample (n = 138) of the 2009 wave respondents. The final sample consisted of 5011 observations by 2765 daily FM cigarette smokers.

Measures

Affordability

We used the individualized version of the RIP as an index of affordability.[14] The RIP is the percentage of per capita income needed to purchase 100 packs of twenty cigarettes. Higher values indicate lower affordability. Instead of using per capita Gross Domestic Product and one measure of price, the individualized RIP uses self-reported income and prices of the last tobacco purchase by smokers to estimate individualized affordability.[18]

The ITC Netherlands surveys ask about gross monthly household income in categories (<€750; €751–1000; €1001–1250; €1251–1500; €1501–1750; €1751–2000; €2001–2500; €2501–3000; €3001–4000; €4001–5000, €5001–6000; €6001–7000, >€7001). Similar to Partos et al.[18] and Nargis et al.,[14] we took the mid-point of each range, except for the highest range which was kept at €7001. In addition to monthly salary, Dutch employers are obligated by law to pay "holiday allowance" in addition to normal salary, which is on average 8% of one's annual gross salary. We calculated annual gross income by multiplying a respondent's monthly income by thirteen (12 months plus holiday allowance). Annual gross

income estimates were inflation-adjusted to 2015 values using Consumer Price Index data. Next, income was equivalised by adjusting for household composition using the Organization for Economic Co-operation and Development (OECD) square root scale.[19,20] This scale, rather than the modified OECD scales, was chosen because it is not dependent on the ages of the children in the household. To estimate household size, measures of marital status and number of children in the household were combined. Respondents were asked about their marital status (not married; not married [or registered partners] but living together; registered partners; married; widowed; divorced). Respondents who said to live together, be married, or be registered partners were assumed to be in two-adult households. Not-married, widowed, or divorced respondents were assumed to be from one-adult households. All respondents reported in each survey wave the number of children under the age of 18 in their household.

At each wave, at least 90.7% (range: 90.7%–95.3%) of daily smokers started to smoke a regular brand and variety of cigarettes. Respondents were asked to elaborate on their last cigarette purchase, by reporting the type of purchase (pack; carton), the number of packs/cartons in the last purchase, total price (per pack[s]; per carton[s]), the number of packs per carton, and the number of cigarettes in each pack. This information was used to derive a price per cigarette for each respondent. The price per cigarette was multiplied by 20 to obtain the price per standard unit (a pack of 20 cigarettes), needed to calculate the RIP. Outliers, price data with a z-score ≥ 3, were transformed to the next most extreme score in the distribution. On average, 3.7 outliers were found per wave (range: n = 1–9). One respondent, who stated to have paid zero euros for cigarettes, was omitted from the analyses. Similar to income, all prices were inflation-adjusted to 2015 euros using Consumer Price Index data.

Predictors

Predictors were a wave, sex, age, and education. Wave was used as a proxy for year. Sex was categorized as male or female. Age was classified into four groups: 18–24, 25–39, 40–54, 55 years, and older. Three levels of education were distinguished (low, moderate, and high). Primary and lower prevocational secondary education was coded as low, middle prevocational secondary education and secondary vocational education as moderate, and senior general secondary education, (pre-) university education, and higher professional education as a high educational level.

Covariates

Cigarettes per day (continuous) and time to first cigarette (<5 minutes, 5–30, 30–60, and more than 61 minutes) were included as indicators for nicotine dependence.[21] A time-in-sample variable was constructed to correct for how many ITC surveys a respondent had completed (1 survey, 2 surveys, 3 or more surveys).[22]

Statistical Analysis

All analyses were carried out in SPSS 27. Generalized Estimating Equation regression models were set up to test for trends over the entire period and differences between consecutive survey waves. Wave was first treated as a categorical variable to test for differences in affordability between consecutive waves using repeated contrasts, and second as a continuous variable to test for linear trends. Models were set up with a normal distribution, identity link, and were fit using the unstructured correlation structure. First, a main effects model including all aforementioned predictors (wave, sex, age, education, time to first cigarette, and time-in-sample) was set up. Next, separate models with interactions between wave and sex, wave and age, and wave and education were set up, assuming a linear trend for wave. Significant interactions were explored through stratified analyses. Bonferroni adjustments of the significance level, that is, 0.05/number of tests, were carried out to correct for multiple testing. Original p-values are displayed in tables and text. Several sensitivity analyses were carried out: (1) using the exchangeable correlation structure, to test for errors in the specification of the correlation structure, (2) omitting the smoking characteristics and time-in-sample to control for possible mediating effects, and (3) using the affordability measure based on household income rather than equivalised income (ie, taking into account differences in a household composition), since we used assumptions to derive household composition.

Results

Study Sample

Table 1 displays the sample characteristics, pooled and per wave. The majority of the pooled sample were female (57.5%), between 25 and 39 years old (32.7%), had moderate education (45.2%), were in a two-person household (40.9%), and smoked their first cigarette between 6 and 30 minutes after waking up (45.3%). On average, respondents smoked 14 cigarettes a day. To compensate for attrition—especially among the youngest age group—replenishment in 2011 and 2015 was done among 18 to 30-year-olds. This explains the relatively large group of 18–24-year-olds in these respective years. In 2020, more respondents had a lower educational level compared to previous survey waves. The average number of cigarettes smoked per day decreased from 15.1 (2008) to 13.3 (2020). Other sample characteristics were similar across waves.

Prices adjusted to 2015 euros, using the Harmonized Indices of Consumer Prices.[23] Error bars display the standard error of the mean.

Trends in Overall Affordability

Figure 1 displays the inflation-adjusted self-reported price and the estimated individualized RIP of the respondents in our sample. Self-reported, inflation-adjusted prices for 20 cigarettes increased from €3.62 in 2008 to €6.98 in 2020. Self-reported income increased from €24 876.91 in 2008 to €33 493.74 in 2020 (not displayed). The estimated RIP, adjusted for predictors and covariates, increased from 1.89% in 2008 to 2.64% in 2020. The Generalized Estimating Equation model found an increasing linear trend in RIP over time, as well as a significant increase in all years compared to 2008 (**Table 2**). When contrasting the RIP of each wave to the next, only significant differences in affordability between 2008 and 2010 were found ($\chi^2(1) = 54.6$, $p \leq .001$) (results not displayed).

Trends in Affordability by Characteristics

We found significant main effects of sex ($p \leq .001$), age ($p \leq .001$), and education ($p \leq .001$) on affordability. Males

Table 1. Sample Characteristics, Per Year (Wave)

	Total (*n* = 5011)	2008 (1) (*n* = 676)	2010 (4) (*n* = 514)	2011 (5) (*n* = 532)	2012 (6) (*n* = 465)	2013 (7) (*n* = 451)	2014 (8) (*n* = 492)	2015 (9) (*n* = 425)	2016 (10) (*n* = 379)	2017 (11) (*n* = 369)	2020 (1) (*n* = 708)
	N (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)	*N* (%)
Sex											
Male	2131 (42.5)	268 (39.6)	230 (44.8)	235 (44.2)	183 (39.4)	173 (38.3)	187 (38.1)	179 (42.1)	168 (44.4)	166 (45.0)	340 (48.1)
Female	2880 (57.5)	408 (60.4)	283 (55.2)	297 (55.8)	282 (60.6)	279 (61.7)	304 (61.9)	246 (57.9)	211 (55.6)	203 (55.0)	368 (51.9)
Age											
18–24 y	864 (17.6)	87 (13.1)	70 (14.1)	146 (28.2)	75 (16.7)	69 (15.5)	80 (16.4)	108 (26.0)	68 (18.3)	59 (16.4)	102 (14.5)
25–39 y	1605 (32.7)	228 (34.2)	157 (31.4)	181 (35.0)	149 (33.1)	151 (34.0)	155 (31.9)	125 (30.1)	119 (32.3)	107 (29.8)	234 (33.1)
40–54 y	1235 (25.1)	187 (28.1)	132 (26.5)	95 (18.4)	109 (24.2)	106 (23.8)	120 (24.8)	87 (20.9)	95 (25.8)	101 (28.1)	202 (28.6)
≥55 y	1209 (24.6)	164 (24.6)	140 (28.1)	94 (18.3)	117 (26.0)	119 (26.7)	131 (26.9)	95 (23.0)	87 (23.6)	92 (25.7)	169 (23.9)
Education											
Low	1187 (23.3)	173 (26.0)	112 (21.8)	116 (21.9)	98 (21.2)	85 (18.9)	109 (22.3)	87 (20.4)	63 (16.6)	66 (17.9)	252 (35.8)
Mod	2325 (45.2)	301 (45.2)	225 (44.0)	241 (45.3)	208 (45.1)	217 (48.1)	206 (42.2)	199 (47.0)	181 (48.1)	172 (46.6)	300 (42.6)
High	1602 (31.6)	192 (28.8)	175 (34.1)	174 (32.8)	155 (33.7)	149 (33.0)	174 (35.5)	138 (32.6)	133 (35.3)	131 (35.5)	152 (21.6)
Household											
1	1841 (36.9)	220 (32.6)	157 (30.7)	200 (37.7)	152 (32.7)	172 (38.2)	201 (41.0)	196 (46.1)	147 (38.9)	145 (39.4)	250 (35.7)
2	2040 (40.9)	283 (42.0)	232 (45.4)	211 (39.8)	210 (45.3)	164 (36.5)	198 (40.4)	169 (39.7)	155 (41.1)	150 (40.8)	267 (38.0)
3	552 (11.0)	82 (12.2)	58 (11.3)	59 (11.1)	45 (9.6)	54 (12.0)	50 (10.3)	27 (6.4)	46 (12.1)	39 (10.6)	91 (13.0)
4	443 (8.9)	71 (10.5)	49 (9.6)	44 (8.2)	46 (9.8)	46 (10.1)	36 (7.3)	28 (6.6)	24 (6.3)	28 (7.7)	72 (10.2)
>5	119 (2.4)	18 (2.6)	18 (3.0)	20 (3.1)	14 (2.5)	18 (3.0)	7 (1.0)	6 (1.2)	8 (1.6)	6 (1.5)	24 (3.0)
TTFC											
5	635 (12.8)	115 (17.1)	59 (11.7)	61 (11.6)	70 (15.2)	39 (8.7)	52 (10.6)	38 (9.1)	28 (7.4)	42 (11.6)	133 (18.8)
6–30	2243 (45.3)	269 (40.1)	215 (42.4)	229 (43.7)	212 (46.2)	207 (46.3)	247 (50.9)	209 (50.2)	178 (48.0)	158 (43.5)	319 (45.0)
31–60	954 (19.3)	105 (15.7)	103 (20.4)	129 (24.6)	91 (19.7)	108 (24.2)	82 (16.8)	60 (14.4)	69 (18.7)	70 (19.2)	138 (19.6)
>61	1116 (22.6)	182 (27.1)	129 (25.5)	105 (20.1)	87 (18.9)	93 (20.8)	106 (21.7)	110 (26.3)	96 (25.9)	93 (25.7)	116 (16.5)
CD	14.2 (7.4)	15.1 (7.5)	14.1 (7.3)	13.8 (7.1)	14.7 (7.6)	14.8 (7.1)	14.7 (7.5)	14.0 (8.2)	13.9 (7.9)	13.7 (7.0)	13.3 (7.3)

CD = cigarettes a day, TTFC = time to first cigarette.

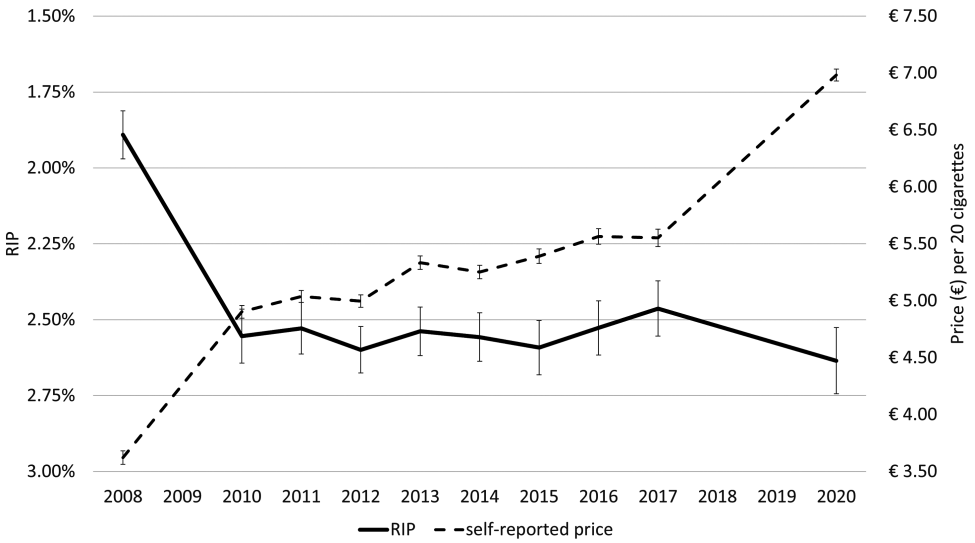

Figure 1. Average self-reported price and affordability (estimated Relative Income Price [RIP]) in the Netherlands 2008–2020.

displayed lower RIPs, and thus higher affordability, than females. Higher RIP was found for individuals aged 18–24 and 25–39 years old (vs. 55 years and over), and with a low or moderate education level (vs. high education) (**Table 2**).

The model found no interactions between wave and sex ($p = .653$) or wave and age ($p = .295$), but did indicate an interaction between wave and education ($p = .007$). Stratified analyses found no linear trend over time among low-educated individuals ($\beta = 0.000$, $p = .149$), but did find an increasing trend in the RIP for moderate-educated ($\beta = 0.0004$, $p = .041$) and high-educated ($\beta = 0.0003$, $p = .025$) individuals. **Figure 2** displays the estimated RIP per educational level, per wave. For all education groups, the estimated RIP was lowest in 2008: Low-educated individuals spent around 2.2% of their income on cigarettes, compared to 1.8% by moderate-educated and 1.6% by high-educated smokers. Compared to 2008, the RIP of low-educated individuals increased significantly after Bonferroni adjustments in 2010 ($\beta = 0.014$, $p \leq .001$), 2011 ($\beta = 0.014$, $p = .003$), and 2012 ($\beta = 0.013$, $p \leq .001$), but not in the other years. Significant, Bonferroni-adjusted, increases from 2008 were found for all years except 2011 ($\beta = 0.003$, $p = .059$) and 2017 ($\beta = 0.004$, $p = .095$) for moderately educated individuals, and all years except 2011 ($\beta = 0.005$, $p = .011$) for high-educated individuals. When contrasting each wave to the subsequent, a significant increase in RIP was found between 2008 and 2010 for all education groups (low: $\chi^2(1) = 17.1$, $p \leq .001$; moderate: $\chi^2(1) = 8.2$, $p \leq .004$; high: $\chi^2(1) = 15.0$, $p \leq .001$). The RIP decreased significantly between 2012 and 2013 for low-educated smokers ($\chi^2(1) = 7.8$, $p = .005$). No other significant changes were found (results not displayed).

Sensitivity Analyses

Sensitivity analyses using the exchangeable correlation structure or omitting smoking characteristics and time-in-sample from the models did not change the results. Analyses using non-equivalised income to estimate the RIP, found that individuals aged 25–39 years no longer displayed a higher RIP, and 40–54-year-olds showed a lower RIP than individuals over the age of 55 years ($\beta = -0.002$, $p = .002$). No significant interactions were found between wave and sex ($p = .311$) and age ($p = .228$), nor with education ($p = .192$) (**Table 2**). When using non-equivalised income, all educational levels indicated a significant linear increasing trend for the RIP.

Discussion

This paper examined the affordability of FM cigarettes in the Netherlands between 2008 and 2020. The individualized RIP increased from 1.89% in 2008 to 2.64% in 2020. Smokers thus had to use a somewhat greater percentage of their income to purchase cigarettes in 2020 than in 2008. Despite the overall decrease in affordability between 2008 and 2020, we found that affordability only changed significantly year-to-year between 2008 (RIP = 1.89%) to 2010 (RIP = 2.55%). From 2010 onwards, the RIP remained between 2.46% (2017) and 2.64% (2020). The prices increased from 2010 onwards and thus might not be substantial enough for people to truly notice it as it did not result in changes in affordability. Our findings reiterate that all tobacco tax increases should be substantial, at least above inflation levels, to ensure that products become less affordable over time.

In our paper, we estimated individual affordability instead of an aggregate measure of affordability most often measured in other studies. Our estimates of individualized affordability indicate lower affordability than aggregate measures. The World Health Organization estimated the RIP, defined as the percentage of Gross Domestic Product per capita needed to purchase 2000 cigarettes of the most sold brand of FM cigarettes, to have increased from 1.31% in 2010 to 1.78% in 2020 in the Netherlands.[24] A study on FM cigarette affordability in Europe in 2010 found a RIP of approximately 1.4% for the Netherlands,[7] while our individualized estimate of 2010 was 2.55%. The discrepancy between the aggregate and individualized measures could be because of different income measures. Gross Domestic Product per capita was almost a third higher than the self-reported annual income in our sample of smokers.[25] Previous studies have found that smoking is becoming more concentrated in disadvantaged—often lower income—groups because of slower declines in prevalence.[11] Furthermore, the individualized measure picks

Table 2. Generalized Estimating Equation (GEE) Estimations of the Relative Income Price (RIP)

	Relative income price (equivalised)[a]		Relative income price (non-equivalised)[a]	
	B (95% CI)	*p*	B (95% CI)	*p*
Year (wave)				
2008 (1)	Ref.		Ref.	
2010 (4)	0.007 (0.005–0.008)	≤.001	0.004 (0.003–0.006)	≤.001
2011 (5)	0.006 (0.004–0.009)	≤.001	0.004 (0.002–0.005)	≤.001
2012 (6)	0.007 (0.005–0.009)	≤.001	0.004 (0.003–0.006)	≤.001
2013 (7)	0.006 (0.005–0.008)	≤.001	0.004 (0.003–0.006)	≤.001
2014 (8)	0.007 (0.005–0.009)	≤.001	0.004 (0.003–0.006)	≤.001
2015 (9)	0.007 (0.005–0.009)	≤.001	0.006 (0.004–0.008)	≤.001
2016 (10	0.006 (0.004–0.009)	≤.001	0.004 (0.002–0.006)	≤.001
2017 (11)	0.006 (0.003–0.008)	≤.001	0.004 (0.002–0.006)	≤.001
2020 (1)	0.007 (0.006–0.010)	≤.001	0.006 (0004–0.008)	≤.001
Sex				
Male	−0.004 (−0.006 – −0.003)	≤.001	−0.004 (−0.005 – −0.003)	≤.001
Female	Ref.		Ref.	
Age				
18–24 y	0.006 (0.003–0.009)	≤.001	0.007 (0.005–0.010)	≤.001
25–39 y	0.002 (0.001–0.004)	.010	0.000 (−0.002 – −0.001)	.621
40–54 y	0.000 (−0.002 – −0.002)	.794	−0.002 (−0.004 – −0.001)	.002
55 y and over	Ref.		Ref.	
Education				
Low	0.009 (0.007–0.011)	≤.001	0.004 (0.002–0.006)	≤.001
Moderate	0.004 (0.003 – −0.005)	≤.001	0.001 (0.000 – −0.003)	.007
High	Ref.		Ref.	
TTFC				
<5	0.003 (0.001–0.005)	.009	0.002 (0.001–0.004)	.044
6–30	0.002 (0.000–0.004)	.016	0.000 (−0.001 – 0.002)	.736
31–60	0.003 (0.001–0.005)	≤.001	0.001 (0.000–0.003)	.126
>61	Ref.		Ref.	
Cigarettes a day (linear)	0.000 (0.000–0.001)	.008	0.000 (0.000–0.000)	.582
TIS				
1	0.003 (002–0.005)	≤.001	0.000 (0.000–0.003)	.008
2	0.001 (0.000–0.003)	.149	0.001 (−0.001 – 0002)	.126
3	Ref.		Ref.	
Separate models				
Wave (linear)	0.0005 (0.000–0.001)	≤.001	0.0004 (0.000–0.001)	≤.001
Sex*Wave		.653		.311
Age*Wave		.295		.228
Education*Wave		.007		.192

TTFC = time to first cigarette, TIS = time-in-sample.
[a]Adjusted for number of household members.
[b]Not adjusted for number of household members (sensitivity analyses).

up the effects of price-minimizing behaviors, such as buying from cheaper sources, which are masked by aggregate measures that rely on the price of a single brand.[18] Another study examined trends in price-minimizing behaviors between 2006 and 2020, and found that the use of these behaviors by Dutch FM smokers ranged from 7.4% to 26.4%—depending on per year and type of price-minimizing behavior.[26]

To the best of our knowledge, this is the first study that uses an individualized version of the RIP to calculate individualized affordability in a high-income country. Partos et al.[18] examined trends in individualized affordability in the United Kingdom between 2002 and 2014, but defined affordability as the percentage of annual income remaining after annual tobacco expenditure. They found that affordability decreased significantly from 2002 to 2014, but also did not find significant year-to-year changes. The individualized version of the RIP has previously been used to estimate (trends in) affordability in Bangladesh[14] and China.[13] Both studies found that cigarettes became more affordable in the selected timeframes, as the average individualized RIP decreased from 16.4% (2006) to 13.6% (2014–2015) in Bangladesh, and from 11.1% (2006) to 5.8% (2013–2015) in China. In both

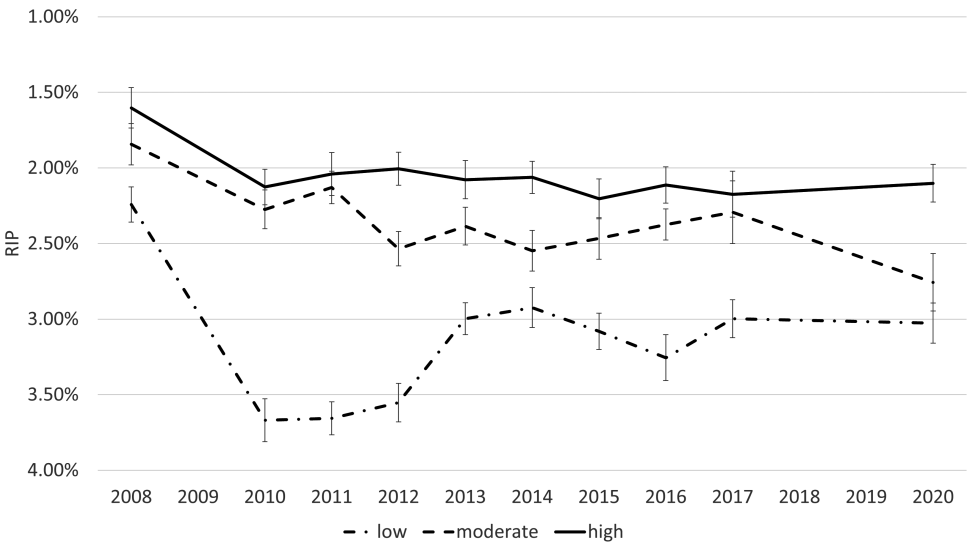

Figure 2. Affordability (estimated Relative Income Price [RIP]) per educational level, per year.

cases, large and fast income growth at the individual level explained the changes in cigarette affordability.[13,14]

Changes in affordability can be attributed to changes in income—as illustrated above—and/or changes in price. Both self-reported price per pack and equivalised income increased between 2008 and 2020 in our sample: from €3.62 to €6.98 per pack (+93%) and from €24 876.91 to €33 493.74 per capita gross annual income (+35%), respectively (both inflation-adjusted). Differences in affordability between subgroups might be income effects. Lower affordability was found among subgroups who, on average, have a lower income level: females (vs. males), 18–24 and 25–39-year-olds (vs. 55 years and over), and individuals with a low or moderate education level (vs. high education). These subgroups, except for young adults, have also been found to be less likely to successfully quit smoking.[10,27] It thus remains important to combine tax increases with other tobacco control measures, in particular those supporting disadvantaged groups, such as full reimbursement of cessation assistance. These measures will not contribute to a change in affordability, but might take away (financial) hurdles that people experience when they want to quit smoking. The impact of income on affordability also became apparent when exploring interactions. Per capita income of the lower-educated group appeared to stagnate or even decreased between 2008 and 2013, resulting in a steeper decline in affordability for lower-educated than moderate or higher-educated individuals. No linear trend in affordability was found for low-educated smokers, while affordability decreased for moderate and high-educated individuals. However, when income was not adjusted for household composition, similar trends in affordability were found across all educational levels (i.e. also a decreasing trend in affordability was found for low-educated smokers). From 2015 onwards, household size shrank for lower-educated respondents. As a result, equivalised income increased more steeply than household income, resulting in differing trends in affordability between the two.

One major limitation of this study is that our analysis was restricted to individuals who solely smoke FM cigarettes. This means that our findings are not generalizable across the entire Dutch smoker population. It is likely that our findings overestimate cigarette affordability, because individuals for whom smoking cigarettes has become too expensive may have switched to cheaper alternatives, such as RYO tobacco, or quit altogether. Another limitation is that we had to estimate annual per capita income, based on monthly gross household income, marital status, and number of children living at home. Both annual income and household size were likely underestimated, because we did not account for end-of-year bonuses, other sources of income, or adult children living at home. As shown by the different trends found between equivalised and non-equivalised affordability for low-educated smokers, further research with more accurate income and household information is recommended. Finally, our findings rely on self-reported data, which may have influenced income and price in particular. Over 25% of eligible respondents were excluded because of not reporting income. Additionally, respondents who were included may have (un)intentionally misreported income or price. Lower earners tend to over-report income, while higher earners tend to underreport their income.[28,29] Our findings could therefore overestimate affordability for lower-income individuals, and underestimate affordability for higher-income individuals.

In conclusion, this paper finds that cigarettes have become less affordable in the Netherlands between 2008 and 2020. But, this appears to mostly be the result of a steep decrease in affordability between 2008 and 2010. From 2010 onwards, affordability remained the same. Affordability is lower among groups who are more likely to have a lower income level. Future tax increases should be large enough to result in a lower affordability.

Supplementary Material

A Contributorship Form detailing each author's specific involvement with this content, as well as any supplementary data, are available online at https://academic.oup.com/ntr.

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Declaration of Interests

GTF has served as an expert witness or a consultant for governments defending their country's policies or regulations in litigation. All other authors have no conflicts of interest to declare.

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Ethics

The survey protocols and all materials, including the survey questionnaires, were cleared for ethics by the Office of Research Ethics, University of Waterloo, Canada (REB#1446, REB#18920/30242, and REB#41704). Ethics clearance in the Netherlands was waived because of minimal risk. All participants provided consent to participate.

Data Availability

In each country participating in the international Tobacco Control Policy Evaluation (ITC) Project, the data are jointly owned by the lead researcher(s) in that country and the ITC Project at the University of Waterloo. Data from the ITC Project are available to approved researchers 2 years after the date of issuance of cleaned data sets by the ITC Data Management Center. Researchers interested in using ITC data are required to apply for approval by submitting an International Tobacco Control Data Repository (ITCDR) request application and subsequently signing an ITCDR Data Usage Agreement. The criteria for data usage approval and the contents of the Data Usage Agreement are described online (http://www.itcproject.org).

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