Addictive Behaviors 34 (2009) 246–251

Contents lists available at ScienceDirect

Addictive Behaviors

Dependence on the nicotine gum in former smokers

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ARTICLE INFO

Keywords:
Tobacco use disorder
Nicotine dependence
Nicotine replacement therapy
Smoking
Internet

ABSTRACT

We conducted an Internet survey in 2004–2007 in 526 daily users of the nicotine gum, to assess use of, and dependence on the nicotine gum in former smokers. We used modified versions of the Nicotine Dependence Syndrome Scale (NDSS-G), the Cigarette Dependence Scale (CDS-G) and the Fagerström Test (FTND-G). After 30 days, 155 participants (29%) indicated their gum use. Higher dependence on the gum predicted a lower chance of stopping using it at follow-up (odds ratio=0.36 for each standard deviation unit on CDS-G, $p=0.001$). More long-term (>3 months) than short-term (<=3 months) users of the gum agreed with: "I use the nicotine gum because I am addicted to it" (83% vs. 7%, $p<.001$), and fewer long-term users reported that they used the gum to avoid relapsing to smoking (42% vs. 92%, $p<.001$). Long-term users had higher ratings of dependence on the gum than short-term users, as assessed with NDSS-Gum, CDS-Gum and FTND-Gum (all $p<.001$). Most long-term users reported symptoms of dependence on the nicotine gum. Lower levels of dependence on the gum predicted cessation of gum use. However, long term use of the nicotine gum has no known serious adverse consequence, and may be beneficial if it prevents late relapse.

1. Introduction

Nicotine replacement therapy (NRT) is effective to treat tobacco dependence: it increases by 7% the chances of quitting smoking, compared with placebo (success rates 17% vs. 10% for placebo) (Silagy, Lancaster, Stead, Mant, & Fowler, 2004). In many countries, NRT products are available in drugstores or on the Internet, without a medical prescription. Because of the lack of medical supervision, there is a concern that some people may use NRT for longer than recommended, or may become dependent on these products (Hughes, 1991; Hughes, Pillitteri, Callas, Callahan, & Kenny, 2004; Hughes, 1998). Long-term use of the nicotine gum is relatively frequent. For instance, in U.S. national samples, 5 to 6% of nicotine gum users used it for more than the recommended duration of 3 months (Shiffman et al., 2000; Shiffman, Hughes, Pillitteri, & Burton, 2003a), and in the UK, 9% of gum users in smoking cessation clinics used the gum for one year or more (Hajek, McRobbie, & Gillison, 2007). In a survey of 805 households that purchased the nicotine gum, 2% purchased it continuously for 6 months or more (Shiffman et al., 2000). In clinical trials, up to 30% of patients use NRT products beyond the recommended 3-month period (Hajek, Jackson, & Belcher, 1988; Shiffman, Hughes, Di Marino, & Sweeney, 2003b; Hughes et al., 1991a; Steinberg, Foulds, Richardson, Burke, & Shah, 2006; Johnson, Hollis, Stevens, & Woodson, 1991; Hatsukami, Huber, Callies, & Skoog, 1993; Hughes, 1989). However, participants in clinical trials usually receive the gum for free, and having to pay for it decreases utilization (Hughes, Wadland, Fenwick, Lewis, & Bickel, 1991b).

Taking a substance over a longer time than intended is a criterion for drug dependence (American Psychiatric Association, 1994), but long-term use does not necessarily imply dependence, because dependence requires other criteria, in particular unsuccessful attempts to quit and withdrawal symptoms upon cessation. Post-marketing data from the U.S., reported by the manufacturers, indicated that only 39 cases of dependence on the nicotine gum were reported per million prescriptions (Spyker et al., 1996). However, the limitations of post-marketing surveillance data are well known (Brewer & Colditz, 1999), and survey data indicate that the prevalence of dependence on the nicotine gum in over-the-counter settings is substantially higher than that, at about 1% of ever users (Hughes et al., 2004). About one third of smokers report having ever used NRT products (Al-Delaimy, Gilpin, & Pierce, 2005). Thus, even if only 1% of users became dependent on the gum, this would still represent tens of thousands of people. Compared to normally compliant users, dependent users use larger amounts of the gum over much longer periods of time (Hughes et al., 2004; Hurt et al., 1995). Thus, dependent users may buy a sizeable part of all the nicotine gums that are sold. Even though some users may be dependent on the gum, it must be emphasized that there is no known adverse consequence of long-term use of NRT, except for the financial cost, and that the potential benefits (i.e., prevent late relapse) far outweigh the drawbacks. This is probably why dependence on the nicotine gum has been generally downplayed in the literature (West et al., 2000). In addition,

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doi:10.1016/j.addbeh.2008.10.018

Table 1
Predictive validity: comparison of ex-smokers who used the nicotine gum daily at baseline and were still using it daily at 30-day follow-up, with those who had stopped using the gum at follow-up

	Still using NRT daily	Stopped NRT at 30-day	*p*	Odds ratio[a]	95% CI for odds ratio	Area under ROC curve	95% CI for area under ROC curve
Number of participants	115	26					
Baseline dependence							
FTND-gum	3.4	2.3	0.02	0.58	0.36–0.93	0.67	0.56–0.79
CDS-gum	41.9	32.3	0.001	0.36	0.19–0.68	0.72	0.60–0.84
NDSS-gum Overall	−0.5	−1.1	0.013	0.52	0.31–0.89	0.66	0.52–0.80

[a] Odds of stopping NRT at follow-up, for each standard deviation unit in dependence ratings.

previous research on this topic was often conducted in small samples (Hatsukami, Skoog, Huber, & Hughes, 1991; Hughes et al., 1986). Thus, the aim of this study was to describe the patterns of nicotine gum use and dependence in a large sample of former smokers.

2. Methods

2.1. Baseline survey

We posted a questionnaire on the Internet between November 2004 and October 2007, in English, on the smoking cessation website StopTabac.ch (Bock et al., 2004; Etter, 2007; Etter & Perneger, 2001). The questionnaire title said: "Survey for users of nicotine chewing gums", and the introductory paragraphs did not mention that we were investigating dependence on the nicotine gum. A link to the survey was posted on other smoking cessation websites, and the survey was listed 4th–8th in Google.com when typing *nicotine gum*, during most of the data collection period. The survey is available at http://www.stoptabac.ch/en/Gums/.

Questions covered ever and current use of NRT products, duration of the current episode of use, number of gums per day, flavor and dose, serious attempts to stop using the nicotine gum in the past year, duration of the previous attempt to stop using the gum, craving for the nicotine gum during the last attempt to stop, reasons for using the gum, and craving for cigarettes (Table 1).

There are several measures of dependence on cigarettes, but we know of no validated measure of dependence on the nicotine gum. The most frequently used measure of cigarette dependence is the Fagerström Test for Nicotine Dependence (FTND) (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). Another scale is the 19-item Nicotine Dependence Syndrome Scale (NDSS), which covers 5 aspects of dependence: Drive, Priority, Tolerance, Continuity and Stereotypy (Shiffman, Waters, & Hickcox, 2004). A third instrument, the Cigarette Dependence Scale (CDS), is a brief (12 items), self-administered, single-dimension measure that covers DSM-IV and ICD-10 criteria of nicotine or tobacco dependence (Etter, Le Houezec, & Perneger, 2003; Etter, 2005). Finally, craving for cigarettes can be assessed with the 4-item Craving subscale of the Wisconsin Withdrawal Scale (WWS) (Welsch et al., 1999).

We modified FTND, NDSS, CDS and the craving subscale of WWS to assess dependence on the nicotine gum. We replaced the words "cigarette" by "nicotine gum", and "smoking" by "using" or "chewing nicotine gum". We modified the NDSS item "I tend to avoid restaurants that don't allow smoking, even if I would otherwise enjoy the food" into: "I tend to avoid places where I cannot chew nicotine gums, even if I would otherwise enjoy the company". We dropped the NDSS item: "Even if traveling a long distance, I'd rather not travel by airplane because I wouldn't be allowed to smoke", because it cannot easily be modified for nicotine gum use. We computed NDSS standardized scores as recommended (Shiffman et al., 2004). We also used some items adapted from the Attitudes Towards Smoking scale (ATS-18) (Etter, Humair, Bergman, & Perneger, 2000; Christie & Etter, 2005).

2.2. Follow-up survey

After 30 days, participants who agreed and indicated an e-mail address received a message inviting them to say whether they were still using NRT, and to indicate their level of craving for the nicotine gum.

Table 2
Characteristics of former smokers who used the nicotine gum daily, according to the duration of gum use, Internet, 2004–2007

	Used gum <=3 months	Used gum >3 months	*p*
Number of participants	217	302	
Men (%)	41.2	36.8	0.32
Age (median)	38.0	47.0	<0.001
Household income (% at or above national average)	81.3	82.8	0.20
Time since they had quit smoking (days, median)	15	960	<0.001
Duration current episode of NRT use (days, median)	14	730	<0.001
Number of nicotine gums per day (median)	6.0	10.0	<0.001
Number of nicotine gums per day (25th and 75th percentiles)	4–8	8–14	<0.001
Dosage=dose*gum/day (nicotine mg/day, median)	14.0	24.0	<0.001
Use neutral flavor (rather than mint or fruit flavor) (%)	24.9	47.8	<0.001
Made a serious attempt to stop using nicotine gum in past 12 months (%)	12.9	37.2	<0.001
Duration of most recent attempt to stop using the gum (days, median)	6.0	2.0	0.037
"Extremely strong" urge to use gum in 1st week of last attempt to stop (%)	29.0	59.2	<0.001
"Extremely strong" urge to smoke in 1st week of last attempt to stop using the gum (%)	20.2	6.8	<0.001
I have had frequent urges to smoke (% agree)	49.3	14.1	<0.001
FTND-gum	1.9	4.0	<0.001
CDS-gum	28.4	47.0	<0.001
NDSS-gum Overall	−1.5	0	<0.001
NDSS-gum Drive	−1.2	0.4	<0.001
NDSS-gum Priority	−0.7	−0.7	0.67
NDSS-gum Tolerance	−1.4	−0.5	<0.001
NDSS-gum Continuity	−0.2	0.7	<0.001
NDSS-gum Stereotypy	−0.1	0.9	<0.001
Minutes to 1st gum of the day, median	60.0	20.0	<0.001
Craving for the gum (4-item scale, 0–4 ratings, mean)	1.6	3.1	<0.001
Stopping all NRTs would be "very difficult"+"impossible" (%)	14.0	60.1	<0.001
Addiction to nicotine gum compared with former addiction to cigarettes (% "same" or "stronger")	9.0	49.5	<0.001
If you decided to stop all NRTs, likely to succeed? (% not likely)	16.1	42.7	<0.001
Reasons for using the nicotine gum (% very+extremely true)			
To deal with my cravings for cigarettes	84.8	32.7	<0.001
To deal with nicotine withdrawal symptoms	72.8	59.6	0.001
To quit smoking or avoid relapsing to smoking	92.3	42.0	<0.001
Because I am addicted to the nicotine gum	6.8	82.8	<0.001
Reasons for NOT stopping the gum (% agree)			
I am a prisoner of nicotine gum	22.7	84.4	<0.001
I fear that I will start smoking again if I stopped using the gum	68.4	56.0	0.016
Chewing a nicotine gum…			
• calms me down when I am stressed	56.7	81.0	<0.001
• helps me concentrate better	44.5	70.3	<0.001

2.3. Comparisons

The recommended duration of nicotine gum use is usually up to 12 weeks after smoking cessation (Anderson, Jorenby, Scott, &Fiore, 2002). To understand why some people used the gum for longer than recommended, we compared short term users (217 former smokers who had used nicotine gum daily for the recommended duration of <=3 months) with long-term users (302 former smokers who were using the gum daily for >3 months). We also compared the 369 former smokers who used the gum daily at baseline and had a FTND-gum score of 0–4 at baseline with those (n=157) who had a FTND-gum score or 5 or more.

2.4. Statistical analyses

We used t tests to compare means, Mann–Whitney U tests to compare medians, chi-square tests to compare proportions, and linear regression models to test associations between continuous variables. To assess whether ratings of dependence on the nicotine gum predicted cessation of gum use after 30 days, we compared baseline former smokers who were using the gum daily at baseline and had stopped using NRT products at 30-day follow-up (n=26) with those who were still using these products daily (n=115) (n=14 occasional gum users were excluded from this analysis). This was considered *a priori* as a crucial test of the validity of the concept of gum dependence, as dependence is supposed to inhibit cessation. We used odds ratios to test predictive validity, using standardized dependence scores as predictors. Odds ratios in Table 2 can therefore be interpreted as change in the odds of stopping the gum at follow-up, for each standard deviation unit in dependence ratings. We also used receiver operating characteristic (ROC) curves to compare the ability of FTND-G, CDS-G and NDSS-G to predict cessation of NRT use at follow-up. ROC curves plot 1-specificity against sensitivity and indicate the ability of a test to predict an outcome (Beck & Shultz, 1986). We assessed change between baseline and follow-up in scores of craving for the nicotine gum (this score is the mean of 4 items adapted from the WWS Craving subscale). We compared 2 groups using these change scores: those who were still using NRT daily at follow-up with those who had stopped using it.

3. Results

3.1. Participation

There were 848 participants at baseline. In all subsequent analyses, we included only the 526 former smokers who used the nicotine gum daily at baseline, and excluded current- and never-smokers, occasional-, past- or never users of NRT, and those who did not use the nicotine gum but used only the nicotine patch, inhaler or tablet. We excluded occasional gum users because we wanted to study dependence on the gum, and assumed that dependence seldom occurs in non-daily users. These 526 participants were on average 43 years old and most (59%) were women. Participants lived in the USA (43%), the UK (30%), Canada (6%), Switzerland, France and Denmark (2% each), other countries (9%), or did not indicate a country of residence (6%). There were 155 participants in the 30-day follow-up survey (29% of 526). Compared with non-respondents, participants in the 30-day survey were similar in term of number of gums used per day (9.1 vs. 8.4, p=0.13), duration of smoking abstinence (median: 300 vs. 189 days, p=0.50) and proportion of men (39.5% vs. 35.5%, p=0.4), but non-respondents were slightly younger than respondents (42.4 vs. 45.2 years, p=0.008).

3.2. Stability of gum use over time

Of the 155 former smokers who used the nicotine gum daily at baseline and took part in the follow-up, 115 (74%) were still using NRT daily after 30 days, 14 (9%) were using it occasionally and 26 (17%) had stopped using it. Among the 115 daily users, the median number of gums by day was 8.5 at baseline and 8.0 at follow-up (p=0.013, from paired-samples t test).

3.3. Internal consistency of the dependence scales

Internal consistency coefficients (Cronbach's alpha) were alpha= 0.63 for FTND-gum, 0.94 for CDS-gum and 0.79 for NDSS-gum.

3.4. Predictive validity

Higher ratings of dependence on the gum at baseline predicted a lower chance of stopping using NRT at follow-up (Table 1). This effect was large, as each additional standard deviation unit on CDS-G almost divided by 3 the odds of stopping NRT at follow-up (odds ratio=0.36, p=.001). The effect was largest for CDS-G, compared with NDSS-G and FTND-G, as shown by odds ratios and areas under the ROC curves (Fig. 1). Scores of the 4-item scale measuring craving for the nicotine gum decreased by 1.1 standard deviation unit (p<0.001, from t test) in the 26 ex-smokers who had stopped using NRT between baseline and follow-up, but craving ratings remained unchanged in the 115 ex-smokers who were still using NRT daily at 30-day follow-up.

3.5. Comparison of short-term and long-term users

In long-term (>3 months) users of the nicotine gum, the median duration of gum use was 2 years (Table 2). Compared with short-term users (<=3 months), long-term users used more gums per day and obtained a twice higher daily dosage of nicotine from the gum. Long-term users were more likely to use the neutral flavor rather that the mint or fruit flavors, and they were more strongly addicted to the gum, as indicated by their ratings on FTND-G, NDSS-G and CDS-G. Half the long-term users rated their dependence on the gum as similar to, or stronger than, their former dependence on cigarettes. Long-term users were less likely than short-term users to use the nicotine gum to avoid relapsing to smoking or to deal with their cravings for cigarettes, and they were more likely to use the gum because they felt they were addicted to it and were unable to stop using it. Long term users also reported higher ratings of craving for the nicotine gum, as assessed with the WWS-G Craving scale, and they were more likely to report that the gum relieved nicotine withdrawal symptoms ("calms me

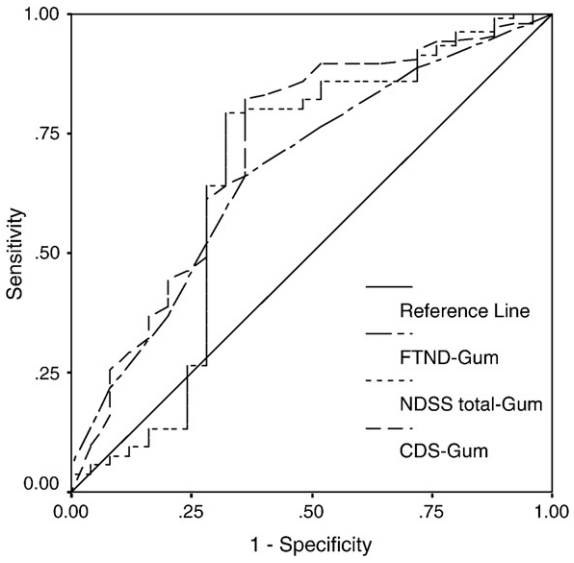

Fig. 1. ROC curves, prediction of abstinence of NRT use at 30-day follow-up, among baseline ex-smokers who used the nicotine gum daily at baseline.

down when I am upset", "helps me concentrate better"). In contrast, long-term users were less likely than short term users to report craving for cigarettes upon cessation of gum use (Table 2).

Compared with those who had a FTND-gum score of 0–4, gum users of had a FTND-gum score of 5 or more were more likely to use the neutral flavor, they reported more urges to use the gum, they were less likely to report that they were using the gum to quit smoking and more likely to report that they used it because they were unable to stop using it (Table 3).

An increased gum consumption over time would suggest that tolerance occurs (a criteria for dependence), or alternatively, that a selection of the most dependent users occurs over time. To test this hypothesis, we examined gum consumption over time. In the whole sample, there was no linear association between duration of use and the number of gums/day. However, in the 332 daily gum users whose current episode of gum use lasted one year or less, each additional month of gum use was associated with chewing 0.36 more gums per day ($p<.001$, from a linear regression model).

Table 3
Characteristics of former smokers who used the nicotine gum, according to their level of dependence on the gum, Internet, 2004–2007

	FTND-gum 0–4	FTND-gum 5 or more	*p*-value
Number of participants	369	157	–
Men (%)	37.4	34.4	0.45
Age (median)	42.0	45.0	0.13
Duration current episode of use (days, median)	91	730	<0.001
Number of gums per day (median)	7.0	12.0	<0.001
Number of gums per day (25th and 75th percentiles)	4.5–10	10–15	<0.001
Use 2 mg gum (%, the rest use 4 mg)	63.1	55.4	0.08
Dosage=dose*gum/day (mg/day, median)	16.0	30.0	<0.001
Use neutral (nicotine) flavor (%)	32.5	50.3	0.001
Use mint flavor (%)	54.7	42.7	–
Use fruit flavor (%)	12.5	5.7	–
Made a serious attempt to stop using the nicotine gum in past 12 months (%)	22.5	35.0	0.006
"Extremely strong" urge to use gum in 1st week of last attempt to stop using the gum (%)	18.4	47.8	<0.001
FTND-gum	2.0	5.8	<0.001
CDS-gum	34.4	50.4	<0.001
NDSS-gum Overall	−1.0	0.2	<0.001
– NDSS Drive	−0.7	0.6	<0.001
– NDSS Priority	−0.7	−0.6	0.77
– NDSS Tolerance	−1.1	−0.4	<0.001
– NDSS Continuity	0.4	−0.2	<0.001
– NDSS Stereotypy	0.2	1.1	<0.001
Minutes to 1st gum of the day, median	60.0	5.0	
Stopping all NRTs would be "very difficult"+"impossible" (%)	27.3	64.2	<0.001
Addiction to gum compared with former addiction to cigarettes (% "same" or "stronger")	18.7	48.4	<0.001
If decided to stop all NRTs, likely to succeed? (% not likely)	24.9	45.2	<0.001
Reasons for use (% very+extremely true)			
To deal with my cravings for cigarettes	57.8	38.3	<0.001
To quit smoking or avoid relapsing	66.8	43.3	<0.001
Because I am addicted to the nicotine gum	35.2	79.6	<0.001
Because I cannot stop using the nicotine gum	28.0	79.3	<0.001
Reasons for NOT stopping the gum (% agree)			
I am a prisoner of nicotine gum	44.7	84.7	<0.001
I fear that I will start smoking again if I stopped the gum	59.6	54.8	0.10
I am unable to stop using the nicotine gum	34.2	75.8	<0.001
Chewing a nicotine gum…			
• calms me down when I am stressed	63.4	80.2	<0.001
• calms me down when I am upset	52.9	75.8	<0.001
• helps me concentrate better	59.8	73.9	<0.001
I have had frequent urges to use nicotine gum	58.6	90.5	<0.001

3.6. Gender differences

The number of gums used per day was similar in men (9.4 gums/day) and women (8.6 gums/day, $p=0.11$). There was no association between gender and being a long-term vs. short-term gum user (Table 2) and with FTND-gum scores (Table 3).

4. Discussion

This survey provides a description of the patterns of use and dependence on the nicotine gum, in a self-selected sample of nicotine gum users who may differ the from those found in representative samples. Most participants in this survey used the nicotine gum for longer than recommended, and many of these long-term users met criteria of dependence on the gum. An interesting finding was that most long-term users attributed their nicotine gum use to addiction. This contrasts with previous, industry-sponsored studies, which reported that only 10–20% of long-term gum users rated themselves as addicted to the gum, or attributed their continuing use to inability to stop using the gum rather than to dependence (Hughes et al., 2004; Shiffman et al., 2003b). Our results are not necessarily in contradiction with previous reports, which concluded that the nicotine gum has a low dependence potential (Shiffman et al., 2003a; Hatsukami et al., 1993; Henningfield & Keenan, 1993). Dependence may occur in only a minority of gum users (and the gum has therefore a low dependence potential), but this minority of users may nevertheless present clear signs of dependence, and represent a sizeable number of people, given the high prevalence of gum use. The DSM-IV criterion of dependence: "the substance is often taken in larger amounts or over a longer period than was intended" was present in long term users, who had been using on average 10 gums per day for 2 years. We can hypothesize that this is probably more than most of them intended when they first used the gum. The DSM-IV criterion: "there is a persistent desire or unsuccessful efforts to cut down or control substance use" was also verified, as over a third (37%) of long-term users had made a serious, unsuccessful attempt to stop using the gum in the previous year. In addition, the median duration of these unsuccessful quit attempts was quite short (2 days), which also suggests the presence of dependence. The DSM-IV criterion of tolerance was assessed with the NDSS Tolerance subscale, and results indicated that long-term users had substantially higher scores of tolerance on the gum than short-term users (Table 1). Dependent gum users were probably dependent on cigarettes before they became dependent on the gum. Thus, they possibly transferred their dependence from cigarettes to the gum, and the gum did probably not create this dependence. Again, this is a hypothesis, as we have no data on participants' previous level of addiction to cigarettes. Finally, half (49.5%) the long term gum users rated their addiction to the gum as similar to, or stronger than their former addiction to cigarettes, which is an additional element in favor of the hypothesis that many long-term users were addicted to the gum.

The occurrence of withdrawal symptoms following abstinence is a central element in the DSM-IV definition of dependence, and withdrawal signs following cessation of gum use have been reported previously (West & Russell, 1985; Hatsukami et al., 1991). Craving is the most specific symptom of nicotine dependence, and in our data, most (59%) long term users reported "extremely high" levels of urge to use the gum during their last attempt to stop using the gum. In longitudinal data, craving for the gum decreased between baseline and follow-up in those who stopped using the gum, whereas craving remained stable in those who continued using it. This result is in accordance with studies on cigarette dependence, which show that in recent quitters, after a few weeks, craving for cigarettes decreases below the level observed in the same people when they were still smoking (Etter & Hughes, 2006). The second DSM-IV criterion for withdrawal: the "substance is taken to relieve or avoid withdrawal

symptoms" was also present in the 59.6% of long-term users who said they used the gum to deal with nicotine withdrawal symptoms, even though they had quit smoking for more than 2 years on average.

4.1. Predictive validity

Higher ratings of dependence on the nicotine gum predicted lower odds of stopping using NRT at follow-up, and this effect was large. This test was specified *a priori* as a crucial validity test for the concept of gum dependence, as the inability to stop using a substance is a central element in the DSM-IV definition of dependence (American Psychiatric Association, 1994).

4.2. DSM-IV criteria of use despite harm, distress and impairment

Some DSM-IV criteria cannot be met in the case of the nicotine gum, in particular use despite knowledge of the harm caused by the substance, distress and impairment. The nicotine gum has few side effects, and its long term use is not known to be harmful. For example, there was no untoward effect of 5 years of nicotine gum use in the Lung Health Study (Murray et al., 1996). A meta-analysis showed that, of smokers who have been abstinent for 12 months, one third eventually relapse to smoking during the following years (Etter & Stapleton, 2006). Because long-term use of NRT may prevent late relapse (Medioni, Berlin, & Mallet, 2005; Steinberg et al., 2006), it could be beneficial to health. Prevention of late relapse was however not the main reason for long-term use of the nicotine gum in our sample, as less than half (42%) long-term users endorsed using the gum to avoid relapsing to smoking, and most (83%) reported using the gum because they felt they were addicted to it. Clinical treatment can help up to 65% of long-term nicotine gum users stop using the gum (Hurt et al., 1995). This success rate is much higher than for smoking cessation treatments, which suggests that addiction to the nicotine gum is not as strong as addiction to cigarettes, probably because the gum delivers nicotine at a slower rate than cigarettes (Benowitz, Porchet, Sheiner, & Jacob, 1988). Thus the main untoward consequences of addiction to the nicotine gum are probably the expenditure and the annoyance of permanent chewing, but our survey did not include a systematic assessment of the untoward consequences of long-term use of the gum.

4.3. Study limitations and strengths

This was not a prevalence survey. The Internet enrollment method probably skimmed a self-selected sample of long-term, addicted gum users. A link to the survey was placed on top of the list in Google. This method may have resulted in the selection of people who were concerned about their use of the nicotine gum. Given the relatively low prevalence of dependence on the nicotine gum in the general population (Hughes et al., 2004), this was, however, a very efficient method to detect and enroll addicted users, and this method enabled us to obtain one of the largest samples of long-term users of the nicotine gum described to date. The Google link was therefore an asset, but this study should not be interpreted as a prevalence study, and our results should not be extrapolated to other populations. However, our aim was not to produce prevalence estimates, but to examine dependence and utilization patterns in long-term gum users and in self-reported addicted users. Studies in representative population samples are needed to establish the prevalence of dependence among NRT users. This is still necessary because the estimate of 1% of dependence among ever users of the nicotine gum is an extrapolation based on the combination of data from 3 different surveys, rather than a result from a single representative sample (Hughes et al., 2004). Finally, an subjective attribution, rather than actual addiction, may explain why some long-term users reported that they were addicted to the gum. However, several converging elements suggest that addiction was indeed present in many gum users.

4.4. Conclusions

In a self-selected sample of nicotine gum users, many long-term users reported symptoms of dependence on the gum. These results extend our understanding on nicotine dependence, because until now it was believed that nicotine dependence occurred only for fast acting products like tobacco smoke, or for slower acting products that provide large amounts of nicotine like snus or chewing tobacco, and dependence on the nicotine gum was generally downplayed in the literature.

Conflicts of interests

The University of Geneva received financial support from Pfizer and Novartis, producers of nicotine replacement products, to develop online smoking cessation programs for users of nicotine replacement products, under the supervision of JFE.

Acknowledgements

Vincent Baujard, from the HON Foundation (www.hon.ch) developed the software for data collection. Funding: none.

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