7. Addiction to Nicotine

Introduction

Addiction to tobacco kills one person prematurely every six seconds. One in two long-term smokers—largely in low- and middle-income countries—will die from tobacco addiction.[1,2] This epidemic reflects the highly addictive nature of tobacco, and specifically of nicotine, its principal addicting component. It is imperative to effectively implement Article 12 of the WHO Framework Convention on Tobacco Control (WHO FCTC), *Education, communication, training and public awareness*, which calls for Parties to promote access to information about the dangers of tobacco consumption and the benefits of cessation.

Forms of Tobacco

Nicotine's effects on a user vary depending on how the nicotine enters the body. Thus, before discussing the critera for addiction or how nicotine addiction develops, it is useful to understand different forms of tobacco. People have used tobacco in various forms for centuries. Historically, tobacco was most often chewed or smoked in pipes. Today, the most common method of using tobacco is in manufactured cigarettes.[3] Tobacco products are generally categorized as combustible (tobacco that is smoked) or non-combustible (primarily various forms of chewing tobacco and snuff).

Combustible Tobacco (Smoked)

Manufactured Cigarettes

Manufactured cigarettes contain shredded and/or reconstituted tobacco combined with hundreds of chemical additives. The contents are wrapped in paper and may have a filter tip. According to the second edition of the American Cancer Society's *Tobacco Atlas*,[4] "cigarettes account for the largest share of manufactured tobacco products in the world—96% of total sales". Although cigarettes are the most common way to consume tobacco, other products predominate in a few countries (e.g. chewing tobacco and bidis in India and kreteks in Indonesia[4]).

Roll-Your-Own Cigarettes

Roll-your-own (RYO) cigarettes are hand-filled cigarettes made from loose tobacco and rolling papers (i.e. cigarette paper). RYO cigarettes can be hand-rolled by the user or made with a hand-held rolling machine.[4] A common misconception is that RYO cigarettes are more natural and therefore "safer" than manufactured cigarettes; however, both contain the same ingredients. Additionally, in all combustible tobacco products, it is the actual burning of the tobacco that produces many of the toxic chemical components in tobacco smoke.

Cigars

Cigars consist of tightly rolled dried and fermented tobaccos wrapped in tobacco leaf. The user draws the smoke into his or her mouth but typically does not inhale it.[5] However, cigar smokers who also smoke cigarettes or are ex-smokers of cigarettes are significantly more likely to inhale the smoke than are users of cigars only.[5] Cigars come in a variety of shapes and sizes (e.g. cigarillos, double coronas, cheroots, stumpen, chuttas, and dhumtis), and they can also be "reverse smoked," which means that the ignited end of the cigar (chutta and dhumti) is placed inside the mouth. Cigars have regained some popularity with both men and women in some parts of the world.[4] In the United States, cigar smoking among women increased fivefold in a six-year period in the 1990s.[6,7]

Pipes and Water Pipes

Pipes are made of a variety of substances, including wood, briar, slate, and clay. Tobacco is placed in the bowl of the pipe, and the smoke is inhaled through the stem. Clay pipes are used throughout South-East Asia.[4] The water pipe (also known as narghile, shisha, hookah, or hubble-bubble) is widely used to smoke tobacco in the Middle East, Northern Africa, and some parts of Asia, and it has gained popularity in some Western countries.[4,8] In some regions, use of the water pipe is more prevalent than use of cigarettes, and in some Arab countries, there is

less stigma associated with women's use of the water pipe than with cigarette smoking.[9]

Hookahs vary widely in shape and size, but the basic design includes a head, consisting of a ceramic bowl with a conical cap; a metal body that is attached to a glass bottle partially filled with water; and a flexible tube with a mouthpiece affixed to the neck of the bottle. The tobacco (shisha, maassel, tumbâk, or jurâk) is moist, shredded, and mixed with sweeteners such as honey, molasses, or fruit. It is placed in the head of the hookah with a heating apparatus (usually charcoal). Combustion begins in the head, and the smoke then passes through the water in the body of the pipe, where it is cooled and diluted before travelling through the hose from which the smoker inhales it.

Approximately three quarters (74.1%) of female university students in Egypt reported preferring smoking tobacco via a water pipe to smoking cigarettes because they believed it to be less harmful.

Many smokers believe that the water in the hookah filters out any harmful toxins, making it a safer alternative than cigarettes or cigars. But as Dr Christopher Loffredo, Director of the Cancer Genetics and Epidemiology programme at Georgetown University, states, "People who use these devices don't realize that they could be inhaling what is believed to be the equivalent of a pack of cigarettes in one typical 30- to 60-minute session with a water pipe because such a large quantity of pure, shredded tobacco is used".[10] Approximately three quarters (74.1%) of female university students in Egypt reported preferring smoking tobacco via a water pipe to smoking cigarettes because they believed it to be less harmful.[11] While the water filtration in a hookah does reduce some toxins, it does not reduce the level of tar in the smoke, which contains the most carcinogens (cancer-causing chemicals). Thus hookah smokers may be at greater risk for harm than cigarette smokers, since water-pipe smokers are exposed to greater overall amounts of nicotine, carbon monoxide, and other toxins.[9]

Bidis

Bidis (pronounced "bee-dees") are thin, hand-rolled, filterless cigarettes consisting of flavoured or unflavoured tobacco wrapped in a tendu or temburni leaf (plants indigenous to India and South-East Asian countries). They may be tied with a coloured string at either end, and they come in a wide variety of flavours (e.g. vanilla, strawberry, mango). Bidis may be perceived as less harmful or more natural than conventional cigarettes; however, bidi smoke contains higher concentrations of nicotine, tar, and carbon monoxide than conventional cigarettes sold in the United States. Tar and carbon monoxide levels of bidi smoke can be higher than those of manufactured cigarettes because the user needs to puff harder to keep a bidi lit.[4] Bidis are India's most used type of tobacco.[4] Jha and colleagues[12] examined prevalence data from India and Sri Lanka and estimate that about half of the male smokers and roughly 80% of the female smokers smoke bidis.

Kreteks

Kreteks are clove-flavoured cigarettes widely smoked in Indonesia.[4] They contain a mixture of shredded clove buds and tobacco, which produces a distinct, pungent smell. Kreteks often contain eugenol, which has an anaesthetic effect and thus allows for deeper inhalation. Clove cigarette smoke contains more nicotine, tar, and carbon monoxide than smoke from conventional cigarettes.[13]

Smokeless Tobacco

Smokeless tobacco comes in two main forms: chewing tobacco and snuff (moist or dry).

Chewing Tobacco

Chewing tobacco is used orally by placing a pinch between the gum and cheek and gently sucking and chewing. According to the *Tobacco Atlas*,[4] "Chewing tobacco is also known as plug, loose-leaf, chimo, toobak, gutkha, and twist. Pan masala or betel quid consists of tobacco, areca nuts and slaked lime wrapped in a betel leaf. These products also contain sweetening and flavouring agents. Varieties of pan include kaddipudi, hogesoppu,

gundi, kadapam, zarda, pattiwala, kiwam and mishri". Chewing tobacco is used throughout the world but primarily in South-East Asia.[4] In Mumbai, India, more than half of the women (56%) chew tobacco.[4]

Moist and Dry Snuff

Snuff users place a small amount of snuff (ground or powdered tobacco) in the mouth between the cheek and gum. Snuff may be either moist or dry. One type of moist snuff is snus. Used primarily in Sweden and Norway—and currently being test-marketed in the United States—snus can be rolled by the user or purchased in porous packs which are placed under the upper lip. Snus that comes in prepackaged pouches does not require the user to spit out the tobacco juice. Dry snuff is powdered tobacco that is inhaled through the nose or taken orally. Once widespread, its use in now in decline.[8] There are a variety of other types of smokeless tobacco products, which are used throughout the world, including khaini, shammaah, nass, and naswa.[4]

Potentially Reduced Exposure Products

The best way to reduce the harm caused by smoking is to quit. But while the adverse effects of smoking are well documented, not all smokers are ready to quit. For decades, tobacco companies have recognized a market of individuals wanting to reduce harm without giving up nicotine and have introduced several potentially reduced exposure products (PREPs)—tobacco-based products that are marketed with the claim of reduced exposure to and harm from the toxins found in tobacco.[14]

The addition of filters to cigarettes in the 1950s to reduce tar intake is an early example of an attempt to reduce exposure to disease-causing agents. Today, in the United States and many other countries, most cigarettes have filters. Some of the new PREPs (e.g. Eclipse, Accord) are lit the same way as a cigarette, but they heat rather than burn the tobacco, theoretically reducing the concentration of toxic combustion products. Other products, such as Omni and Advance cigarettes, are claimed to reduce levels of toxins through different tobacco curing or fermentation processes or by adding chemicals (such as palladium) to the tobacco leaves. Still others are claimed to reduce nicotine levels by using genetically engineered tobacco leaves (e.g. Quest). Finally, there are several oral non-combustible tobacco products. Hard tobacco lozenges, or "cigaletts" (e.g. Ariva and Stonewall) and tobacco packets (e.g. Revel and Exalt) are currently marketed as tobacco alternatives to smoking, but not as cessation products.

A cigarette is an efficient, well-engineered nicotine delivery device that has proved to be deadly when smoked regularly. Nicotine from a smoked cigarette will reach the brain in as little as 7 seconds after inhalation.

There has been much debate about whether these PREPs promote harm reduction or are just another marketing ploy by the tobacco industry to keep people "hooked". The evidence of whether PREPs are associated with reduced risk has been inconclusive. A recent study found the levels of tobacco-specific nitrosamines (TSNAs, the cancer-causing chemicals found in tobacco) in PREPs to be low for some brands and as high as levels found in conventional cigarettes for other brands.[15] More studies are needed to settle this debate.

Nicotine Content

A cigarette is an efficient, well-engineered nicotine delivery device that has proved to be deadly when smoked regularly. Nicotine from a smoked cigarette will reach the brain in as little as 7 seconds after inhalation.[16] A typical cigarette contains approximately 0.5 to 1.0 g of tobacco and, on average, 10 mg of nicotine.[8,17] A cigarette is typically smoked in 10 puffs and within 5 minutes.[17] A typical smoker will absorb 1 to 2 mg of nicotine, but absorption can range from 0.5 to 3 mg.[18,19] The elimination half-life of nicotine is 2 to 3 hours, meaning that the level of nicotine in the blood decreases by one half after a smoker stops smoking for that length of time.[19]

Cigars vary in size, as does their nicotine content. Cigars commonly have from 5 to 17 g of tobacco,[5] and

the tobacco contains from 10 mg to more than 300 mg of nicotine.[20] Most cigars do not have filters and take an hour or more to smoke.

Nicotine concentrations in the tobacco of bidis (21.2 mg/g) have been found to be significantly higher than the concentrations in manufactured filtered (16.3 mg/g) and unfiltered cigarettes (13.5 mg/g).[21]

A typical pipe (e.g. a clay bowl filled with tobacco, with smoke inhaled through a stem) will use 3–4 g of tobacco.[8] Much more tobacco is used in a typical water-pipe (e.g. hookah) session—on average, 20 g.[8] Nicotine levels after smoking a water pipe for 45 minutes are reported to be higher than those measured after smoking a cigarette.[8]

Smokeless tobacco products vary considerably in nicotine content, pH, and levels of various carcinogens. Since nicotine is absorbed through the buccal mucosa of the smokeless tobacco user's mouth, uptake is affected by both the pH of the tobacco product and the pH of the mouth.[8,22] The rate of absorption and action for nicotine from smokeless tobacco is thus slower than that from tobacco that enters the body via the lungs when smoked. The delayed effect may make smokeless products less addictive than cigarettes.[23] However, some smokeless tobacco users report that quitting cigarettes is easier than quitting smokeless tobacco.

A study of six popular brands of moist snuff found that nicotine content ranged from 3.4 mg/g to 11.5 mg/g.[24] The highest concentrations of nicotine are in dry snuff, which has an average of 16.8 mg/g, followed by moist snuff (12.6 mg/g) and chewing tobacco (9.9 mg/g).[24] Use of smokeless tobacco is associated with cancer of the pharynx, larynx, and oesophagus.[25,26] The process of fermenting and curing smokeless tobacco increases the levels of TSNAs, which exist in relatively low concentrations in green tobacco.[27] Content of TSNAs varies widely among different forms of smokeless tobacco. Swedish snuff (snus) contains the lowest levels of TSNAs (2.8 µg/g of dried tobacco),[28] whereas Skoal® and Copenhagen®, two popular brands in the United States, contain high levels: 64.0 µg per gram of dried tobacco and 41.1 µg per gram of dried tobacco, respectively.[29]

Creation and Maintenance of Addiction

Nicotine's Effects

The role of nicotine in addiction has been extensively reviewed and reported (see, for example, the Royal College of Physicians' 2007 report on harm reduction;[8] Matta et al.'s 2007 review of the guidelines on nicotine dose selection for in vivo research;[30] and Brigham on the addiction model[31]). The following is a brief overview of nicotine's role in the development and maintenance of addiction.

The active ingredient for addiction is nicotine, a naturally occurring drug found in all the different forms of tobacco. Nicotine is highly addictive, as addictive as heroin and cocaine.[25,32] All leading authorities, including WHO, the Royal College of Physicians, and the American Psychiatric Association (APA),[33-35] have supported the three major conclusions of a 1988 report by the Surgeon General of the United States[32] regarding nicotine and tobacco:

1. Cigarettes and other forms of tobacco are addictive.
2. Nicotine is the drug in tobacco that causes addiction.
3. The physiological and behavioural processes that determine tobacco addiction are similar to those that determine heroin and cocaine addiction.

All forms of tobacco have the potential to be addictive because they all contain nicotine, but cigarettes are the most efficient for delivering nicotine into the body.[33]

The tobacco industry has long understood the role of nicotine. A leading Philip Morris nicotine researcher, William L. Dunn, concluded in 1972:

> *The cigarette should be conceived not as a product but as a package. The product is nicotine … Think of the cigarette pack as a storage container for a day's supply of nicotine … Think of the cigarette as a dispenser of a dose unit of nicotine … Think of a puff of smoke as the vehicle of nicotine … Smoke is beyond question the most optimized vehicle of nicotine and the cigarette the most optimized dispenser of smoke.* (quoted in Hurt & Robertston[36])

Nicotine is an alkaloid found in abundance in the tobacco plant and to a much lesser degree in potatoes, eggplants, and tomatoes.[8] Nicotine's effects on the brain and on body systems have been reviewed extensively (see, again, Royal College of Physicians,[8] Matta[30]).

Nicotine is classified as a stimulant drug, but many people who use it report decreased arousal. Nicotine produces paradoxical effects, acting as both a stimulant and a depressant. As a stimulant, it has been shown to increase attention, memory, information processing, and learning.[30,37] It has also been shown to alleviate anxiety, depression, and pain. For these reasons, smokers often report that smoking is a stress reliever and that they are more apt to smoke in response to stressful situations or negative moods.[38]

As noted above, inhalation of nicotine in the form of smoke provides the quickest delivery,[30,37] with nicotine reaching the brain in approximately 7 seconds.[16] Nicotine stimulates the dopaminergic pathways of the mesolimbic system in the brain, an area that is involved in reinforcement for other drugs of abuse.[39] Nicotine binds to the nicotinic acetylcholine receptors in the brain (nAchRs), causing the release of dopamine in the nucleus accumbens[40] and the subsequent release of neurotransmitters, resulting in a variety of physiological effects, including behavioural arousal and neural activation.[19] Release of dopamine, norepinephrine, and serotonin is associated with pleasurable feelings and also with appetite suppression. The excess release of acetylcholine associated with nicotine consumption is related to improved attention,[41] increased vigilance in the performance of repetitive tasks, and memory improvements.[19,41] These pharmacological effects play a large role in maintaining smoking behaviour in the addicted smoker.

Nicotine improves mood. Smokers commonly report increased pleasure and reduced anger, tension, depression, and stress after smoking a cigarette. It is unclear whether these effects are due to the effect of nicotine on the brain or to the alleviation of withdrawal symptoms. The perceived calming effect from the reduction of withdrawal symptoms may be what nicotine users find reinforcing. Some of these effects may be pharmacological, but some of the sedating psychological effect of smoking comes from the smoker's perception of coping with stress successfully while smoking.[16]

Nicotine also affects metabolism by decreasing appetite and increasing metabolic rate.[38] Evidence of this metabolic effect can be found in the weight gain by ex-smokers, an average of 4 kg of body weight after quitting.[42] Increased appetite can persist for several months upon quitting.[40] Weight control and reduction of appetite are critical aspects of the appeal of smoking for many women and girls. Further, weight gain and fear of weight gain can be important deterrents to smoking cessation, particularly among women.[43,44] Both girls and women are more likely to smoke to control their weight than males are.[6] Studies have shown that girls and women are more fearful of weight gain than boys and men are and may use smoking as a method of weight control.[45] Additionally, some studies have found that women gain more weight after quitting than men do.[45,46] Research suggests that women who quit smoking may also be at a greater risk of resuming smoking in order to avoid weight gain.

Weight control and reduction of appetite are critical aspects of the appeal of smoking for many women and girls.

Women experience greater subjective pleasurable effects from tobacco smoke than men do.[47] Research has also shown that male and female smokers differ in their intake of nicotine. Women do not take in as much nicotine as men do and appear to have greater sensitivity to nicotine's effects on reducing both negative affect and body weight.[42] Rates of nicotine metabolism are also significantly higher in women smokers who use oral contraceptives[30] and those who are pregnant.[48]

Criteria for Addiction

Addiction is a term commonly applied to maladaptive drug-seeking behaviour, often performed despite knowledge of negative health consequences. Nicotine meets the established criteria for a drug that produces addiction, specifically, dependence and withdrawal. Both WHO in its *International Classification of Diseases (ICD)*[49] and the APA in its *Diagnostic and Statistical Manual (DSM-IV &*

DSM-IV-TR)[34,50] have issued diagnostic criteria to assess dependence and withdrawal. Both WHO and APA recognize dependence as, in essence, the repetitive and compulsive use of a drug. Withdrawal is a syndrome of symptoms that occur when a regular user abruptly stops use (e.g. following or during a quit attempt). Nicotine withdrawal and dependence are viewed as separate, albeit related, disorders, each with its own specific diagnostic criteria.[34]

Addiction and dependence are often used synonymously by both WHO and APA. With dependence, tolerance to a drug—i.e. a decreased response to a repeated dose of the drug—can often occur. In essence, more nicotine is needed to produce the same effects that were once produced by lower doses. Neuroadaptation occurs when the brain has adapted to the presence of nicotine and needs nicotine in order to function normally.[19] When nicotine is not available (such as when a smoker stops smoking), the brain function becomes disturbed, resulting in withdrawal.

The diagnostic criteria for dependence-producing drugs are given in Table 7.1.

Greater nicotine dependence has been shown to be associated with lower motivation to quit, difficulty in trying to quit, and failure to quit,[51] as well as with smoking the first cigarette earlier in the day and smoking more cigarettes per day.[32,52]

Withdrawal produces a constellation of symptoms that tobacco users may experience when they stop tobacco use abruptly (see Table 7.2 for a list of the criteria for nicotine withdrawal). Withdrawal symptoms vary but include a craving for nicotine, irritability, frustration or anger, anxiety, depression, difficulty concentrating, restlessness, and increased appetite (which can lead to weight gain). Most symptoms reach maximum intensity 24 to 48 hours after cessation and then gradually diminish over a period of a few weeks.[19] Some withdrawal symptoms, such as dysphoria,[18] mild depression,[18] anhedonia,[18] and increased appetite,[6,40,33] may persist for months.

It is important to note that withdrawal is neither necessary nor sufficient for the development of dependence.[34,49] For instance, intermittent smokers (e.g. "chippers"), social smokers, and non-daily smokers may meet the criteria for nicotine dependence but may not meet the criteria for withdrawal disorder.[8] Shiffman and Paty found that chippers do not appear to smoke to avoid nicotine withdrawal symptoms; rather, smoking by these low-level smokers was associated with more "indulgent" activities such as socializing, eating, and drinking alcohol.[53]

Withdrawal and dependence can be associated; persons who show signs of dependence (e.g. high tolerance to nicotine and difficulty quitting smoking) are more likely to experience withdrawal symptoms if they discontinue smoking. Withdrawal symptoms are also related to the severity of dependence, and they may increase temptations to smoke and alleviate the withdrawal, especially within the first 30 days after cessation. Withdrawal symptoms can be present, albeit in a milder form, when a smoker

Table 7.1. Diagnostic Criteria for Nicotine Dependence

Dependence is a maladaptive pattern of substance use, leading to clinically significant impairment or distress, as manifested by three (or more) of the following, occurring at any time in the same 12-month period:

1. Tolerance, as defined by either
   - a need for markedly increased amounts of the substance to achieve the desired effect, or
   - markedly diminished effect with continued use of the same amount of substance.
2. Withdrawal, as manifested by either
   - the characteristic withdrawal syndrome for the substance, or
   - the substance being taken to relieve or avoid withdrawal symptoms.
3. Taking larger amounts of the substance or over a longer period than was intended.
4. A persistent desire for or unsuccessful efforts to cut down on substance use.
5. A great deal of time being spent in activities necessary to obtain or use a substance.
6. Abandonment or reduction of important social, occupational, or recreational activities because of substance abuse.

Source: Ref. 50.

reduces the number of cigarettes smoked or switches to a low-nicotine cigarette.[54]

Withdrawal can begin within hours of smoking the last cigarette, and symptoms typically peak within one to three weeks after stopping use,[46] reaching maximal intensity during the first week.[40] Cravings can persist for months, especially if triggered by situational cues.[40] Hendricks and colleagues[55] found that nicotine withdrawal occurs quickly after abstaining from smoking, with nicotine-dependent study participants who abstained from smoking reporting greater cravings (a symptom of withdrawal) for cigarettes after 30 minutes than non-abstaining nicotine-dependent participants.

Cessation Rates

As discussed in greater detail in the chapter of this monograph on quitting smoking, dependent smokers have low rates of smoking cessation and total abstinence from cigarettes. Research suggests that cessation may be more difficult for women than for men.[44,56] Examination of cessation rates provides some insight into the addictive nature of nicotine and the difficulty associated with stopping. In the United States and some other countries, most cigarette smokers (70%) report wanting to quit smoking; however, it is estimated that each year less than 1% of self-quitters (i.e. smokers who quit without any formal treatment intervention) will actually succeed.[57] SRI International[58] reported that the US Centers for Disease Control and Prevention (CDC) found only a 5% abstinence rate after three months for people who quit "cold turkey" (i.e. abruptly and without assistance). Hughes and colleagues[59] found that only one third of the smokers who quit on their own remained abstinent after two days, only one quarter after seven days, and less than one in five (19%) after one month.

Further evidence of the addictive nature of nicotine is the high rate of relapse (i.e. return to smoking), even among people faced with life-threatening illnesses. A recent study of more than 5000 patients receiving treatment for coronary heart disease in 15 European countries revealed that only half of them quit smoking after suffering a heart attack.[60] Even more compelling, Walker and colleagues[61] found that more than 40% of patients smoked at some point after having surgery to remove non-small-cell lung cancer, and more than one third (36.9%) of them were smoking one year post-surgery. Resumption of smoking was related to shorter quit duration prior to the surgery and more-intense cravings.

It is not uncommon for smokers to "slip" or even relapse after a quit attempt. Most smokers who manage to quit will make 8 to 11 attempts before actually succeeding.[6] For most smokers, quitting represents stopping an addiction they have had for many years. Aside from breaking the addiction to nicotine, smokers have to break the many associations they have with smoking (e.g. smoking while relaxing, talking on the phone, or in a car). It is not difficult to understand why so many smokers who have quit slip or relapse when these triggers are present.

Slips can be defined as the re-engagement of some smoking behaviour (e.g. smoking less than a whole cigarette

Table 7.2. Diagnostic Criteria for Nicotine Withdrawal

A. Daily use of nicotine for at least several weeks.

B. Abrupt cessation of nicotine use or reduction in the amount of nicotine used, followed by four (or more) of the following signs within 24 hours:

1. dysphoric or depressed mood
2. insomnia
3. irritability, frustration, or anger
4. anxiety
5. difficulty concentrating
6. restlessness
7. decreased heart rate
8. increased appetite or weight gain.

C. Clinically significant distress or impairment in social, occupational, or other important areas of functioning.

D. Symptoms not due to a general medical condition and not better accounted for by a mental disorder.

Source: Refs. 34, 50.

on one or more occasions) that does not progress into a full-blown relapse (i.e. resumption of a regular smoking pattern). But a slip is often viewed as a failure, which can be very demoralizing and can lead to relapse. Both slips and relapse should be viewed as learning experiences[62] and part of the process of recovery from addiction.[63] Failed quit attempts should be reframed as learning experiences of what to do and what not to do in future quit attempts.[62] Smokers are most likely to relapse in the first three months but can be vulnerable to relapse through the first year following a quit attempt.[62]

Evidence shows that around 50% of those who start smoking in the adolescent years continue to smoke for 15 to 20 years.

How Nicotine Addiction Develops

Addiction to nicotine does not happen quickly, after using tobacco once or twice; it develops over time. Most smokers go through a series of steps from experimentation to regular use on their way to becoming addicted. Particularly in the industrialized countries, most people addicted to nicotine initiated smoking during adolescence. As many as one third to one half of adolescents who experiment with smoking go on to become regular smokers.[64] In the United States, more than 90% of current adult smokers began smoking before the age of 18.[65] The younger an individual is when he or she experiments with smoking, the more likely he or she is to become a regular or daily smoker. For example, two thirds of children who begin smoking in the sixth grade become regular adult smokers, and almost half (46%) of those who initiate smoking in the eleventh grade become regular adult smokers.[66] Evidence shows that around 50% of those who start smoking in the adolescent years continue to smoke for 15 to 20 years.[67] Unfortunately, sales to minors (addressed in Article 16 of the WHO FCTC, *Sales to and by minors*) often go unregulated. The following brief overview of smoking initiation in industrialized countries such as the United States is elaborated further in the chapter on initiation and maintenance of tobacco use.

It can take from months to three years for a person to become addicted to tobacco.[25] The Surgeon General of the United States[25] reported that children and adolescents progress through the following stages in developing an addiction to tobacco:

1. Forming attitudes and beliefs about tobacco
2. Trying tobacco
3. Experimenting with tobacco
4. Regularly using tobacco
5. Becoming addicted to tobacco.

A more recent stage-based conceptualization of smoking initiation uses the framework of the Transtheoretical Model of Intentional Behaviour Change (TTM).[63,68,69]

The TTM describes the process as one in which individuals move through the following five stages on the road to developing a well-maintained pattern of behaviour: precontemplation, contemplation, preparation, action, and maintenance.[69] The stages of smoking initiation are similar to but distinct from those of cessation or recovery.[63,68]

Figure 7.1 presents an overview of the stages of addiction as well as the stages of recovery. The top set of arrows (addiction) represents the stage progression of individuals who are in the process of adopting a new behaviour (e.g. smoking) moving from non-use (pre-contemplation, PC) to dependence (maintenance, M). The bottom set of arrows (cessation) represents the stage progression of individuals who are in the process of recovering from an addiction, moving from precontemplation (PC, unwilling or unable to stop the behaviour) to maintenance (M, sustained cessation). Movement through the stages (both addiction and cessation) is affected by the processes of change (behavioural and experiential), the individual's context (e.g. current life situation, beliefs and attitudes, interpersonal relationships), and markers of change (e.g. self-efficacy, decisional balance). Although the process is represented as linear, individuals can move backwards and forwards through the stages and often have to recycle through them before maintaining change.

Precontemplation is the stage in which individuals who are not considering adopting or changing a particular behaviour have become interested in acquiring a new one. This first stage would be experienced by youth who have never smoked cigarettes but are beginning to form or have already formed attitudes and beliefs about smoking. Beliefs at this stage are often negative but can be affected by media exposure or role modelling (i.e. parental smoking). In terms of initiation of smoking behaviour, a youth in precontemplation would be a non-smoker who is not considering smoking at any time in the foreseeable future.

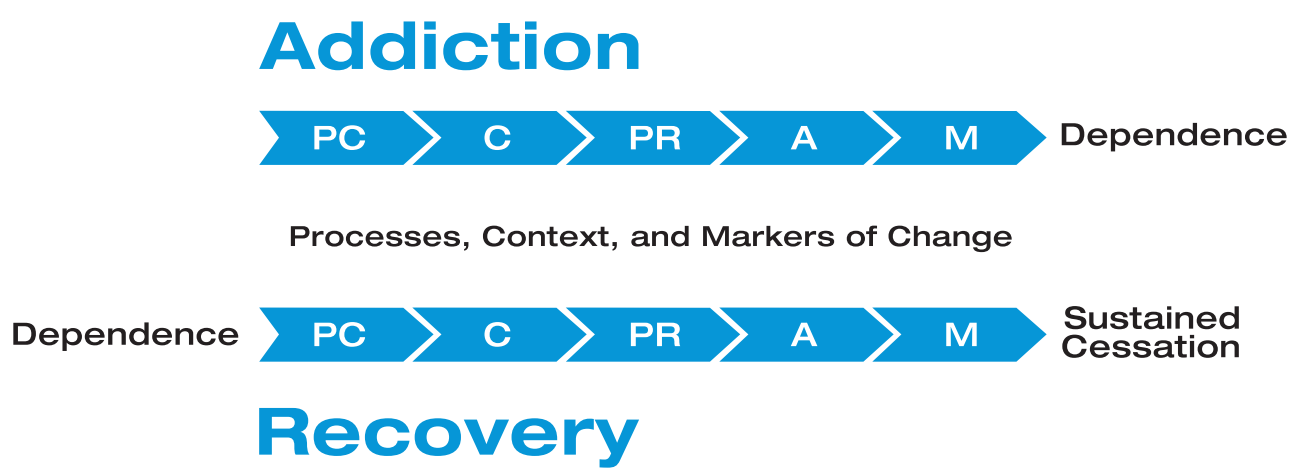
As the adolescent enters *contemplation*, he or she becomes more aware of smoking, is open to considering smoking, and/or experiences some desire to experiment with smoking. Typically, the environmental pressures to smoke (e.g. media messages or peer pressure) are more salient to young people in this stage. They may think about trying smoking, but they are not fully committed to adopting the new behaviour. Experimentation can be considered part of this process, as the first few attempts produce important information that influences the decision to continue.

Youth in the *preparation* stage not only are interested in smoking but also have some intention to smoke in the near future, typically within the next 30 days. A youth in this stage of smoking initiation might seek out individuals who smoke and may begin to experiment with cigarette smoking. The initial reaction to experimentation with cigarettes (e.g. dizziness and/or positive reinforcement from friends) may determine the youth's progression through the stages. In addition, tobacco advertising may become more influential at this stage, and the person experimenting with smoking may begin to find more pros than cons with regard to the practice.

The *action* stage is defined by some pattern of regular smoking behaviour. As youths progress through this stage, they begin to change their environment so that the behaviour is more likely to occur. The action stage typically consists of up to six months of a regular pattern of smoking. An adolescent in action will repeatedly, but usually irregularly, smoke cigarettes. Smoking behaviour in this stage tends to occur in certain situations, such as at parties. If smoking behaviour is not viewed as sufficiently reinforcing, individuals may move back into one of the earlier stages of smoking initiation.

The fifth stage, *maintenance*, firmly establishes the addiction and consists of ongoing integration of cigarette smoking into the individual's life. An adolescent who is regularly using cigarettes will do so in many different contexts, such as before and after school, while driving a

Figure 7.1. Overview of the Stages of Addiction and Recovery



Note: PC = Precontemplation
C = Contemplation
PR = Preparation
A = Action
M = Maintenance

Adapted from *Addiction and Change: How Addictions Develop and Addicted People Recover*, with permission from author.[63]

car, or while alone, in a regular pattern of use. Individuals in this stage have an established pattern of regular smoking that has lasted for more than six months.

Psychosocial Risk Factors for Initiating Tobacco Use

Numerous factors are associated with an adolescent's progression through the stages of tobacco use. These factors include being in a lower-SES group;[70,71] owning promotional smoking merchandise;[72] overestimating peer smoking prevalence;[73] the adolescent's environment, including attitudes and behaviours of friends, siblings, and/or parents;[74] underestimating the addictive properties of smoking;[75] lack of parental monitoring;[76] low levels of academic achievement;[74,77] and previous experimentation with tobacco products.[78]

These factors appear to be related to an increase in risk for both boys and girls; however, some factors have more influence on girls than on boys in their progression through the process of initiation. For instance, available research indicates that girls who use tobacco tend to have stronger attachments to peers and friends than boys have; they also tend to overestimate smoking prevalence in their environment, are less committed to school, are less knowledgeable about nicotine and addiction, and usually have parents or friends who smoke.[6] Like women, girls are more likely than boys to believe that smoking can be a way of controlling weight.[6]

Behavioural and Psychological Factors of Nicotine Addiction

As discussed earlier, nicotine is a key and necessary component in the development of smoking addiction; however, behavioural, psychological, environmental, and social factors also contribute to the development and maintenance of addiction.

Since a typical smoker takes 10 puffs on each cigarette, a person who smokes a pack of cigarettes a day (20 cigarettes per pack) will receive 200 doses of nicotine daily.[18] No other drug is dosed at such a high frequency. This conditioning, in addition to the presence of nicotine, is critical to the addiction process. A pack-a-day smoker who smokes for 14 years will have over 1 million dosing opportunities. This repeated dosing, coupled with the fact that withdrawal symptoms are often averted with each cigarette, makes nicotine one of the most addictive drugs.

In addition to the repeated dosing of actual nicotine, certain behaviours, such as bringing the cigarette from hand to mouth at the same frequency, co-occur with the dosing. Other behaviours, such as smoking the first cigarette of the day or smoking after a meal, while on the phone, or driving a car, also become associated with smoking and reinforce continued use. As people progress from the action to the maintenance stage, smoking becomes conditioned and connected to more and more behaviours or becomes more firmly connected to specific times, events, and experiences. Behavioural factors, such as the hand-to-mouth motion, may be more critical and reinforcing for women than for men and more important than nicotine.[42,47]

Smokers often identify one of the main benefits of smoking as its calming effects. As mentioned previously, smokers begin to experience impairment of mood and performance within hours of their last cigarette, and certainly overnight, as they begin to experience withdrawal symptoms. These effects are completely alleviated by smoking a cigarette. According to Jarvis,[40] "smokers go through this process thousands of times over the course of their smoking career, and this may lead them to identify cigarettes as effective self-medication, even if the effect is the negative one of withdrawal relief rather than any absolute improvement". As any former smoker will tell you, it takes months or even years to achieve the extinction of these conditioned cues.

Social and Environmental Influences and Marketing

Social and environmental influences can both discourage and encourage tobacco use. For instance, enactment and enforcement of smoke-free policies, taxes, and social sanctions can discourage use and affect rates of initiation and progression to addiction; being surrounded by smokers (e.g. peer group or family members) can encourage smoking.[8,40] Marketing, portrayal in the media, and brand preference of specific populations (such as women and youth) can influence the progression to regular

use and addiction.[8] The guidelines for the implementation of Article 13 of the WHO FCTC, *Tobacco advertising, promotion and sponsorship,* developed and adopted by Parties to the treaty, review a number of different forms of tobacco advertising, promotion, and sponsorship and make recommendations to effectively ban each of them.

The tobacco industry developed "light", or "low-tar", cigarettes in a misleading attempt to address concerns of smokers about the health effects of smoking. Smokers may smoke "light" cigarettes as an alternative to quitting, believing they are reducing their risks by smoking a lower-tar cigarette. A 2006 study[79] found that use of "light" cigarettes was common, and more than one third of the users reported using those cigarettes to reduce health risks. These smokers were about 50% less likely to quit than those who smoked non-"light" cigarettes.

More women than men smoke "light" or "ultra-light" cigarettes—almost two thirds of women smokers (63%) and less than half of men smokers (46%).[80] A common misconception is that "low tar" or "light" means low risk. "Light" cigarettes are not less harmful than regular cigarettes. "Light" cigarettes have that designation because when measured on standard smoking machines, they produce lower levels of nicotine and tar. However, most people do not smoke in the same manner as smoking machines. "Light" cigarettes are as dangerous as regular cigarettes because of the increased ventilation in the "light" cigarettes' filters. Smokers engage in compensatory smoking, meaning they inhale deeper in an effort to achieve the same amount of nicotine, which leads to inhaling the same amount of tar. Smokers of "light" cigarettes tend to smoke a higher number of cigarettes, inhale deeper, hold the smoke in their lungs longer, and/or take more-frequent puffs in an effort to satisfy their nicotine craving.[8,81] Additionally, smokers often cover the holes in the filter with their lips and/or fingers, which allows them to get as much nicotine as they would get from smoking a regular cigarette.[18,82]

In the United States in August 2006, US District Court Judge Gladys Kessler ruled that the use of descriptive labels of "low-tar" or "light" on tobacco products is false and misleading, because it implies a more healthful product and should not be used.[83] This ruling, made in a lawsuit of the US government against the tobacco industry, is currently on appeal, and the tobacco companies continue to market "lights" and "low-tar" cigarettes. The WHO FCTC obligates its Parties to eliminate misleading descriptors from tobacco packaging in Article 11, *Packaging and labelling of tobacco products*.

Conclusion

It is critical to remember that all tobacco products can be deadly and addictive, regardless of their form or disguise.[84] Women and girls are beginning to follow the same trajectory of initiation into smoking as men, with variable patterns depending on sociocultural and economic status. All users of tobacco are at risk for increased morbidity and mortality. However, women face unique challenges such as greater difficulty in quitting and differences in tobacco-related health risks, including nicotine metabolism, weight issues, osteoporosis and increased risk of fracture, early menopause, and effects on sexual and reproductive health.

Nicotine is a powerful drug that meets all established criteria for a drug that produces addiction—specifically, dependence and withdrawal. Nicotine is as addictive as heroin and cocaine, and it has the paradoxical effects of being a stimulant and a depressant. No other drug doses at such a high frequency: a pack-a-day smoker who smokes for 14 years will have more than 1 million dosing opportunities.

Girls and women are more likely to smoke to control their weight than males are, and they tend to gain more weight after quitting smoking. Female smokers also derive greater subjective pleasurable effects from nicotine than males who smoke. They are at increased risk for female-specific reproductive issues, including painful, irregular periods; earlier menopause; and increased risks among those who use certain birth-control methods.

WHO and APA have issued diagnostic criteria for assessing dependence and withdrawal, the key components of addiction. Dependence is a maladaptive pattern of substance use in which tolerance develops (in the case of smoking, more nicotine is needed to produce the same effects that were once produced by lower doses). Withdrawal is a constellation of symptoms that a tobacco user may experience when he or she abruptly stops tobacco use (including irritability, anxiety, and increased appetite).

Smoking initiation by young people can be conceptualized as a series of five stages: precontemplation, contemplation, preparation, action, and maintenance. Female-specific issues with smoking initiation include concern about weight, less commitment to school, and stronger ties with peers.

Increasing effort should be devoted to developing better prevention strategies and investigating methods of cessation that are gender-specific. More research is needed on the addiction process in all types of tobacco use, as well as in the various subtypes of tobacco users (e.g. non-dependent "chippers"). In addition, more research is needed on the initiation process into smoking and the transitions from experimentation to addiction, as well as on identifying specific risk and protective factors for girls and women. Prevention and intervention strategies should be tailored to these factors.

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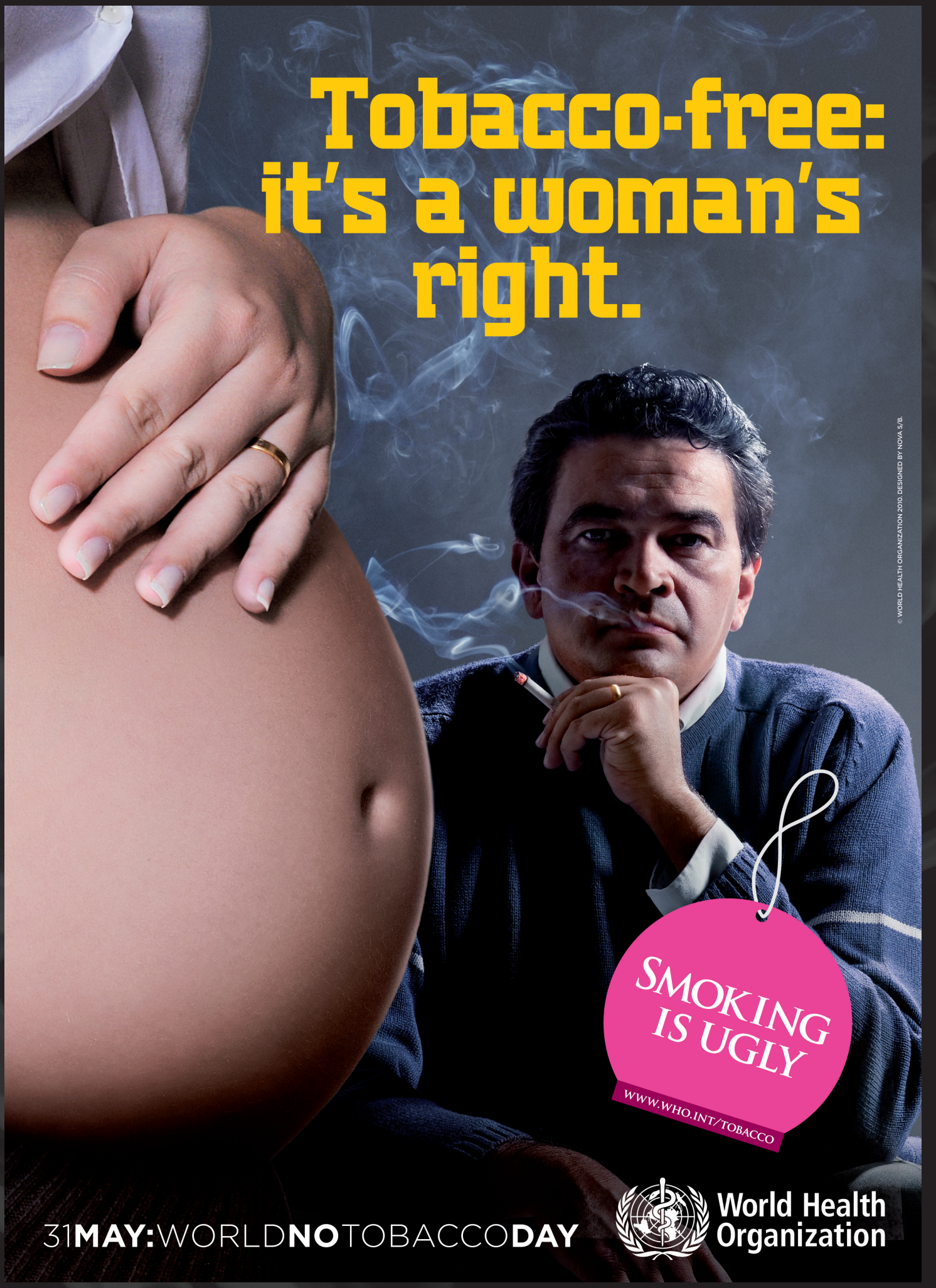
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