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Effective Identification and Cessation of Tobacco Consumption Using Gesture Analysis: A Review

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Abstract— *Tobacco consumption continues be a considerable issue in today's society. Apart from the obvious health problems that arise through consuming tobacco products, various social, cultural, and economic predicaments can also be linked to this matter. Thus, the need for tobacco cessation is now greater than ever. Tobacco cessation must begin with proper identification of individuals who regularly consume tobacco products, separating them from people who are exposed to second-hand smoke. Unfortunately, current methods of identification have their own unique drawbacks, and they may not always align with the other procedures of the complete cessation model. Consequently, the need has arisen for a unified cessation model that takes proper identification into account as well. Gesture analysis, along with a points-based rewards system may be the key to solving this dilemma. This method of cessation will rely heavily on replacing the temporary satisfaction and gratification supplied by tobacco consumption, with a more tangible, rewarding and wholesome form of gratification.*

Keywords— **Abstinence; carbon monoxide; smoked tobacco; smoking cessation; tobacco; tobacco use cessation**

I. INTRODUCTION

One of the most pervasive harmful behaviours in the world is tobacco use. According to recent findings made by the World Health Organization, there are around 1 billion smokers worldwide, and direct tobacco use causes over 7 million deaths annually, while 1.2 million further deaths are caused by indirect exposure to second-hand smoke [1].

Nicotine, tar, and more than 4000 additional compounds, along with over 40 carcinogens, can all be found in tobacco smoke. 20 of these carcinogens have been proven to convincingly cause tumours [2]. Carbon monoxide (CO), often quoted as a "forgotten killer," is rarely reported, regardless of its notoriety for being a potent toxin. Accurate measurement is necessary for a reliable assessment of the hazards related to cigarette exposure, and thereby the importance of cessation and temperance from tobacco-based products. However, certain groups of people are more hesitant than others to admit to using tobacco products. This is especially true for expectant mothers and parents of small children, for whom smoking is frequently seen as inappropriate behaviour. It could also be challenging for some people to recollect having used cigarettes. More objective solutions have been proposed because relying on self-report and the various biases it introduces may result in unreliable measures of tobacco exposure.

Thus, this review article was planned in order to choose the pertinent literature and evaluate, compare, and critically evaluate the results reached from the numerous investigations conducted into this matter. This article also probes into an alternative method for effective identification of active smokers and thereby cessation of tobacco consumption; utilizing hand-to-mouth gesture analysis with a points-based rewards system.

For the sake of simplicity, further statistics and data will be considered within the limits and scale of our country.

II. SOCIOECONMIC AND SOCIAL IMPACT OF SMOKING

Sri Lanka, the tropical island of over 22 million people, is facing one of the worst political and economic crises in decades. The early months of 2022 saw a nationwide fuel and food crisis, which only worsened when Sri Lanka defaulted on its external debts, which amounted to more than $50 billion, and declared a state of bankruptcy [3].

In addition to these catastrophes, inflation skyrocketed to an unprecedented 64.3% in August 2022 [4]. Food inflation, job losses, rising commodity prices and costs of living meant that poverty also saw a significant growth, with the poorer population being the most affected. It is also estimated that poverty will continue to remain above 25% for the next few financial years.

Consequently, alcohol consumption has dropped by over 20%, however, we are yet to see a considerable decline in tobacco consumption [5]. Government statements also indicate that the Sri Lankan government has spent approximately Rs. 100 billion on treating alcohol and tobacco related diseases in 2022, even during the current economic crisis.

Thus, it will be extremely beneficial to design, develop, test and implement an effective system to diminish the consumption of tobacco in the country. Such a system must be able to effectively separate individuals engaged in smoking conscientiously, from individuals who are inadvertently affected by smoking (e.g: indirect exposure to tobacco through second-hand smoke). Thus, as a preliminary step in this process, we must first be able to identify members of the population that actively participate in smoking tobacco products.

III. IDENTIFICATION OF SMOKERS

As of today, there are 2 main procedures for testing and identifying users of tobacco products: breath analysis and cotinine testing.

Breath analysis includes testing a sample of air exhaled by the examinee for traces of carbon monoxide (CO), a by-product of tobacco products containing tar. Quantitative evaluation of the results thus obtained can be used to deem whether the examinee is an active smoker, a passive smoker or someone who has recently quit.

The earliest implementation of such a method has been documented by Jarvis et al and Ward et al, who have additionally tested for carboxyhemoglobin in blood samples obtained from the examinees. They were the first to note that considerable CO concentrations in the body, either in exhaled air or as carboxyhemoglobin in the blood, are an objective and unbiased indication of tobacco consumption, and thereby habitual smoking [6] [7].

This method has proved to be effective with pregnant women, as a good correlation can be observed between the breath CO levels of maternal women and the end-tidal CO of their newborn infants. The amount of CO in foetal breath can be used to determine the percentage of foetal carboxyhaemoglobin.

In contrast to this, cotinine testing refers to directly testing for the cotinine compound in tissue samples obtained from examinees [8]. Cotinine is more stable and consistent than nicotine, lingering for longer periods of time in the body due to its extended half-life. Common tissue samples used to check for cotinine levels include blood, saliva and urine [9].

A more effective approach towards cotinine testing is obtaining hair samples, which can provide good indications for long-term smoking, even for as long as 1 – 3 months, whereas other tissue samples only indicate abstinence or usage within the past 4 days [10].

However, it has been noted that breath analysis is more favourable than cotinine assay when it comes to pregnant women [11]. Regardless, a lower cutoff point of 3 – 4 ppm is used when it comes to pregnant women.

Both of the afore-mentioned methods have a unique advantage in that they both allow dichotomous separation of smokers and non-smokers through biochemical criteria, ensuring greater assent in decision-making, rather than biased and unreliable self-reporting. This is extremely important when it comes to obtaining data from cultures where individuals, especially women have particular moral and cultural constraints regarding the usage of tobacco products (like in Sri Lanka), resulting in severe underreporting of cases.

IV. DRAWBACKS OF CURRENT IDENTIFICATION METHODS

The above methods of identification have yielded multiple demerits, and each method has unique drawbacks that interfere with the intended results of the methods.

First and foremost, both methods are invasive up to a certain extent. Examinees, especially heavy smokers who have been condemned and stigmatized for their habits, may find it difficult to agree to being tested. This may prove to be troublesome for hospitals and other entities engaged in smoking cessation programs.

Apart from this, cotinine testing has also been criticized for providing unreliable results under certain conditions. For example, the half-life of cotinine in the body has been found to depend on various external factors, which include the age and gender [12] of the examinee, pregnancy, renal function (for urine-based cotinine testing), among others. This shortcoming has been thoroughly discussed by Florescu et al [9].

A major drawback of both methods, especially when it comes to cessation, is their inability to differentiate between active smokers and passive smokers who do not have any addictions to tobacco products. This can be done up to a certain extent by quantitatively analysing test results and neglecting outlying/anomalous results, but these outcomes are not entirely reliable at times.

Accordingly, it is important to develop and implement a system capable of surpassing these shortcomings successfully.

V. IDENTIFICATION THROUGH GESTURE ANALYSIS

Obtaining inputs for tobacco use cessation through gesture analysis would essentially transcend the afore-mentioned demerits. This is because, unlike cessation based on the above methods, which relied heavily on inputs provided by biochemical markers (CO and cotinine), a gesture analysis method would utilise the repetitive hand motion of a smoker to measure and quantify his/her smoking behaviour.

A clear advantage of this method would be its ability to yield extremely reliable results, rather than using biochemical markers, since the hand motion of drawing a cigarette (or similar tobacco product) to one's mouth is only exhibited by heavy or regular smokers. This allows us to exclude any passive smokers or similar outliers in our tests.

Senyurek et al [13] have already conducted extensive studies into this method. They have quantitatively shown that, while this method of identification on its own has significant accuracy in test groups within controlled environments, it shows lacklustre performance in free-living conditions, where regular hand motions (such as covering coughs, eating and other similar hand motions) gave false positives.

In consequence, additional methods must be employed to validate any results obtained through this method. A good supporting indicator for this is the test subject's heartbeat. An extensive study conducted by Ramakrishnan et al [14] revealed that a smoker's heart rate increased from 83.8±13.7 bpm 10 minutes prior to smoking, to 90.5±16.4 bpm during smoking, and returned to baseline after 30 minutes approximately. Measuring this increase in heart rate and correlating the results with the readings obtained in the gesture analysis will yield considerably accurate outcomes.

VI. CLASSIFCATION THROUGH POINTS AND REWARDS PROGRAM

Using the afore-mentioned model of identification, we can build a wearable electronic device similar to a wristband, which can be fitted with an accelerometer, gyroscope, magnetometer and heart rate sensor. This device can thus obtain the necessary readings for heart rate and gesture analysis, which can then be fed to a server online, which will analyse and identify correlations between the measurements.

This device can also be connected with a smartphone app, which the individual currently engaging in tobacco cessation (or preparing to commence cessation) can install on his/her smartphone. This app has several functions, including

i. Obtaining an initial value for the amount of cigarettes consumed daily: the average amount of cigarettes (or similar tobacco products) consumed by the user can be entered initially during the onboarding of the app. Alternatively, instead of letting the user manually enter this information (which can lead to emotional and psychological biases), the app can provide the user with an option to let the app calculate this amount, by obtaining readings from the wristband for a particular period of time (e.g: 1 week). This period of time can be changed and customized by

ii. Tracking the consumption habits of the user: after the onboarding, the app must continuously obtain data from the user's wristband and keep records of these readings. For example, every 2 weeks or so, the app will calculate the average consumption of the user, starting with the value initially entered. Thus, after each set period of time, the user's average will be updated, setting new milestones for the user to surpass over time.

iii. Rewarding the user: using the average cigarette consumption of the user, the app can then reward the user with digital points if they have consumed less cigarettes than the previously set average value, and deduce points obtained by the user if they have consumed more. After the onboarding, users can be provided with an initial amount of points for user retention and to balance out any points lost by the user during the first few weeks of using the app and the wristband.

The points thus obtained by the user can be redeemed by him/her to be spent on coupons and discounts for various purposes. Effective options for redeeming points include food and beverage delivery services, purchasing commodities and other activities which provide gratification for the achievement made by the user. This, in turn, enhances the effects of the delayed gratification reached by the user, allowing them to focus on setting themselves a new milestone in their tobacco cessation journey. This method of abstinence and cessation will be extremely effective, since it replaces the temporary gratification and pleasure that comes from indulging in tobacco consumption, with a more rewarding, tangible and progressive medium of satisfaction. Thus, users will immediately associate the feeling of stronger gratification with an improvement in the quality of their life, thereby ensuring that continuous personal development is maintained throughout the period of cessation.

The most significant merit of this method of tobacco cessation is granting the user the ability to achieve temperance in a gradual and effective manner, while not having to reach out to other entities for support. Unlike in

other tobacco cessation models, this method can be implemented by the user themselves, without needing to come into contact with hospital, medical authorities and tobacco cessation support groups. This reduces the user being exposed to the social, cultural and ethical stigmas behind smoking, which can severely affect the path needed to be taken to reach abstinence [15].

VI. CONCLUSION

Tobacco and all of its related products are notorious for the various negative impacts they have on the health of whoever consumes them. Considering the massive socioeconomic impact that tobacco consumption has on our nation, it is imperative that government entities, medical authorities and everyone concerned in this matter turn their attention towards effective methods of tobacco cessation.

Tobacco cessation must begin with a proper identification stage, where active smokers and consumers can be identified and dichotomously separated from entities that cause anomalous or incorrect identifications. Presently, breath analysis and cotinine testing (both methods utilizing biochemical markers for identification) are being used today, with each method having its own demerits.

Thus, the need has arisen for a unified, procedural and sustainable model of tobacco cessation, which can be achieved as depicted throughout this paper by the use of hand-to-mouth gesture analysis and a points-based rewards system. Implementing this system in the real world requires individuals to wear a wristband-like device that records their hand motions and correlates that data with heart rate readings, to determine whether a user has engaged in smoking or similar activity. Users are then awarded points on a smartphone app when they have smoked below their average amount of consumption, and get points reduced vice versa. Earned points can be made to be reimbursed as coupons and discounts that the user can redeem and spend on commodities and services, leading to delayed gratification and boundless personal development and temperance.

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