International Journal of Developmental Neuroscience 67 (2018) 14–18

Contents lists available at ScienceDirect

International Journal of Developmental Neuroscience

journal homepage: www.elsevier.com/locate/ijdevneu

Brain-derived neutrophic factor in adolescents smoking waterpipe: The Irbid TRY

Mahmoud A. Alomari[a,*], Nihaya A. Al-sheyab[b], Omar F. Khabour[c], Karem H. Alzoubi[d]

[a] Division of Physical Therapy, Department of Rehabilitation Sciences, Faculty of Applied Medical Sciences, Jordan University of Science and Technology, PO Box 3030, Irbid 22110, Jordan
[b] Faculty of Nursing, Maternal and Child Health Department, Jordan University of Science and Technology, Irbid, Jordan
[c] Department of Medical Laboratory Sciences, Jordan University of Science and Technology, Jordan
[d] Department of Clinical Pharmacy, Jordan University of Science and Technology, Irbid, Jordan

ARTICLE INFO

Keywords:
Waterpipe smoking
BDNF
Youth risk behavior survey
Students
Tobacco
Jordan

ABSTRACT

Background: Brain-derived neutrophic factor (BDNF) and tobacco consumption can affect many body functions and health. However, the relationship of BDNF with waterpipe (Wp) smoking is unknown. Therefore, the current study examined the relationship between Wp smoking and BDNF in adolescents.
Methods: Self-reported tobacco consumption and serum BDNF were determined in 195 waterpipe and 288 nonsmokers in 7th–10th grade students.
Results: Stepwise regression that included Wp smoking, gender, BMI, and location, showed that only Wp smoking ($p < 0.0001$) and gender ($p < 0.0001$) were related to serum BDNF. In addition, the ANCOVA found a main effect for Wp smoking ($p < 0.0001$) and gender ($p < 0.0001$) with lower BDNF in males smoking waterpipe.
Discussion: BDNF was diminished in adolescent Wp smokers, which might predispose adolescents for systematic adverse health and behavioral alterations. These results extend the negative health risks associated with cigarette smoking to that of water-pipe tobacco smoking.

1. Introduction

Brain-derived neutrophic factor (BDNF) is most abundant and functions in the hippocampus and hypothalamus. It is pivotal for neuronal survival, migration, synaptogenesis, differentiation, and dendritic arborization (Yeom et al., 2016). It contributes immensely to data learning, retention, and processing, intelligence, and attention throughout the lifespan, including schoolchildren (Yeom et al., 2016). Additionally, BDNF appears to be involved in energy (Chaldakov et al., 2009), cardiovascular (Alomari et al., 2014; Alomari et al., 2015a), and musculoskeletal (Matthews et al., 2015) homeostasis. In fact, a study showed that women with higher plasma BDNF were at less risk of all-cause mortality than women with lower plasma BDNF (Krabbe et al., 2009).

Tobacco consumption is a serious public health concern. Waterpipe (Wp) smoking is a tobacco consumption style, during which smoke from burned "Moassel" tobacco on a charcoal, passes through a bowl of water into a hose then inhaled into the smoker's mouth. Contrary to developed countries, adolescent tobacco consumption in developing countries is on a steady rise (Mzayek et al., 2012; Al-Sheyab et al., 2014). Similarly, Wp smoking among adolescents, in particular, has recently gained popularity. In fact, the prevalence of adolescent Wp smoking in many countries is greater than that in adults (Akl et al., 2011) and has surpassed cigarette smoking (Al-Sheyab et al., 2014; Alomari and Al-sheyab, 2017), reaching > 50% in some countries (Al-Sheyab et al., 2014; Alomari and Al-sheyab, 2017). Aroma, flavor, atmosphere, social acceptance, curiosity, novelty, accessibility, affordability, and alular, among other factors, have been implicated in the accelerated increase in Wp consumption (Jawad et al., 2013). However, health misconceptions have been pivotal in driving the worldwide spread of Wp, especially among adolescents (Jawad et al., 2013). Every so often, Wp has been promoted as a "less harmful" alternative to cigarettes. It is thought the passing of smoke through the water can "cleanse" the smoke from toxicant, thus minimize the adverse health effects of smoking (Shihadeh et al., 2012). Additionally, more than often, the fruit flavoring of Wp tobacco makes smokers believe that Wp smoking is healthier than cigarettes (Jawad et al., 2013). In fact, it is the harms from cigarettes combined with flavoring agents and the paraphernalia used in the Wp process (Kadhum et al., 2015). Smoking Wp presents a greater level of the same types of toxicants of cigarettes

* Corresponding author.
E-mail addresses: Alomari@just.edu.jo (M.A. Alomari), nasheyab@just.edu.jo (N.A. Al-sheyab), khabour@just.edu.jo (O.F. Khabour), KHAlzoubi@just.edu.jo (K.H. Alzoubi).

https://doi.org/10.1016/j.ijdevneu.2018.03.007
Received 4 January 2018; Received in revised form 9 March 2018; Accepted 11 March 2018
Available online 16 March 2018
0736-5748/

including a surge of nicotine, metallic elements, particulate substances, and countless carcinogens (Kadhum et al., 2015). However, toxicants derived from charcoal combustion and, flavored smoking mixture with the infection risk due to sharing Wp gear (i.e. mouthpieces), certainly surpass the harms of cigarettes (Kadhum et al., 2015). Additionally, many Wp smokers don't consider themselves smokers and can quit smoking any time (Jawad et al., 2016). Unfortunately, studies have shown that dependency is high (Aboaziza and Eissenberg, 2015) while quitting rate is low (Jawad et al., 2016) among Wp smokers.

Previous studies have shown that Wp smoke contains substantial concentrations of toxic compounds compared to cigarette smoke (Shihadeh and Saleh, 2005; Kim et al., 2016). For example, the magnitude of "tar" from a single Wp session is typically several folds higher than that produced from a single cigarette (Primack et al., 2016). Similarly, the amount of CO exposure is estimated to be ~3 folds higher during Wp versus cigarette smoking (Cobb et al., 2015) while polycyclic aromatic hydrocarbons are considerably higher (Sepetdjian et al., 2010). Importantly, Wp smokers inhale substantially more smoke in a single puff, thus is exposed to more toxicants then cigarette smoking (Eissenberg and Shihadeh, 2009).

Adolescent tobacco consumption is associated with cardiovascular, respiratory, immune, metabolic, hormonal, and neural diseases and morbidity (Mathers and Loncar, 2006; Mortality, 2015), and accounts for > 20% of global mortality (Renteria et al., 2016; World Health Organization, 2011). Interestingly, a wide array of brain functional and structural alterations have been reported in smokers. These alterations include apoptosis, decreased synaptic activities, gray matter volume, and densities in the cerebral cortex and hippocampus regions (Durazzo et al., 2010). Obviously, these areas are essential for BDNF production and function, and data learning and retention (Yeom et al., 2016).

Few studies examined the effect of cigarette smoking on BDNF. In adults, smoking was associated with an increase (Kim et al., 2007; Jamal et al., 2015) and a decrease (Colle et al., 2016) in BDNF level, but then again normalized with smoking cessation (Bhang et al., 2010). Despite the global spread (Al-Sheyab et al., 2014; Alomari and Al-sheyab, 2017) and the adverse health effects (Kadhum et al., 2015) of Wp tobacco consumption, no studies have examined the effect of Wp smoking on BDNF level. Therefore, the current study examined the relationship of Wp smoking on serum BDNF levels among adolescents. Levels of BDNF are expected to be lower in adolescent smokers versus nonsmokers, which might provide additional knowledge about the health effects of Wp smoking among adolescents.

2. Method

2.1. Design and recruitment

This study is of a descriptive, cross-sectional design, aimed to examine the relationship between Wp smoking and serum BDNF in adolescents. The current data is part of the "Irbid Tobacco Risk in Youth (Irbid-TRY)" longitudinal project (Alomari and Al-sheyab, 2017; Alomari and Al-Sheyab, 2016); aiming at identifying the health-related risks of tobacco smoking. The study used a multistage cluster sampling technique with the educational district, school, and class were the unit of cluster. A closed envelope technique was used to randomly select eight representative public high schools in North of Jordan after schools were stratified by sex (4 of each sex). Subsequently, 7th-10th grade classrooms (average classroom size is 30 students) were randomly selected within each participating school, through which healthy high school students were invited to participate. The exclusion criteria were student self-reporting of acute medical conditions of hyperglycemia, hypertension, hyperlipidemia, hypercholesterolemia, cardiac conditions, and psychiatric and stress-related mood disorders. Written informed consents as well as child assents were sought from parents and participating children, respectively. The study was approved by the Institutional Review Board of Jordan University of Science and Technology, the Jordanian Ministry of Education, and the relevant educational districts in North of Jordan. Socio-demographic characteristics, tobacco smoking patterns, and blood samples were taken from all participating adolescents, as described below.

2.2. Smoking status

The validated Arabic version of the Youth Risk Behavior Survey was used to obtain self-reporting of tobacco patterns (Mzayek et al., 2012; Brener et al., 2013). Two questions were used to assess Wp smoking pattern: "Have you ever smoked a waterpipe?", and "have you smoked waterpipe in the past 30 days?". Adolescents were considered current Wp only smokers when selected Wp smoking, but not any other type of tobacco consumption in the past month (Mzayek et al., 2012). Students reported other types of tobacco smoking were excluded.

2.3. Blood samples

Blood samples were collected from the cubital vein in plain tubes for BDNF serum level analysis. After coagulation, samples were centrifuged at 1500 xg, serum were transferred into sterile 1.5 tubes and stored at −80 °C until used.

2.4. Serum BDNF measurements

ELISA method was used to determine BDNF levels in serum, using commercially available kits (Human BDNF Duoset Kit R&D system, USA), according to the manufacturer's instructions. Absorbance was measured at 450 nm using Epoch Biotek microplate reader (BioTek, Winooski, VT, USA). All samples and standards were measured in duplicates. Samples from smoker and non-smoker students were included in ELISA plates, and possible variability between different assays was controlled using 4 samples of known BDNF concentrations (Alomari et al., 2015a; Khalil et al., 2016).

2.5. Statistical analysis

All statistical analyses were conducted using SPSS software for Windows (version 22.0; Chicago, IL). Data are expressed as means ± SD, and α was preset at $P < 0.05$. A series of simple linear regressions were used to determine the individual relationship of smoking status (i.e. none versus Wp only smoking), gender, age, location (rural versus urban), and BMI with BDNF. Subsequently, a stepwise regression was used for the factors were significantly related to BDNF in the simple linear regression to predict the BDNF level in participating adolescents. A 2-way ANCOVA was used to examine the differences in BDNF level according to smoking status (i.e. none versus Wp only smoking) and gender, while covariating for age, location (rural versus urban), and BMI.

3. Results

3.1. Participants

The participant characteristics are presented in Table 1. Blood samples and smoking status were collected from 483 adolescents, 195 of which were Wp smokers, whereas 264 were females. Data were collected from adolescents attending four rural (n = 261) and four urban (n = 222) public schools, four of which were exclusively for males and four were exclusively for females. Recruitment was from 68 classrooms, 36 of which were for females. Two male and female schools were invited from each area (i.e. rural vs. urban). The students volunteered from 7th (n = 132), 8th (n = 120), 9th (n = 136), and 10th (n = 94) grades.