Effects of Using Innovative Technology Heat Not Burn on Indoor Air Quality.

Prof.Asoc.Dr. Etleva Muça (Dashi)[a]

[a] *Agricultural University of Tirana. Faculty of Economy and Agribusiness. Dep. of Economy &Rural Development Policies. TR. AL*

Abstract

Today the indoor air quality is considered one of the main concerns of many international institutions related to environmental and health issues and polluted air is considered dangerous for human health. WHO (World Health Organization) has estimated that approximately 3.8 million people die every year prematurely from illness attributable to household air pollution [1].

Science and technology are combined together to create innovative smoking techniques in order to reduce the harm of smoking. As a result, Heat Not Burn revolutionary technology is introduced. This review study is focused on evaluating the smoking effects on indoor air quality comparing traditional smoking with new technologies and smoking techniques.

Actually, the use of new techniques such as THS (Tobacco Heating System) or electronic device IQOS (I Quit Ordinary Smoking) has lower pollution effects compared to the traditional type of smoking. The use of new techniques results in the lowest concentrations of formaldehyde, benzene, toluene, PM2.5, among the majority researched pollution sources. So, this paper is based on a literature review approach analyzing the newest debates on the topic with the aim to give conclusion and recommendations on the long-term period on the use of new smoking technologies and future expectations.

Keywords 1

Indoor smoking, New smoking technology, THS, IQOS

1. Introduction

Today more and more people are being sensitive to health problems in general and they caused by smoking. Many efforts are made to reduce the harm of smoking. Heat Not Burn technology is one of the results of these efforts and researches. People in developed and developing countries spent the majority of their living time indoors. [2],[3]. Spending most of their time indoors people are the main contributor with their style of living on environmental pollution. Actually, through several studies it is proven that most hazardous compounds in tobacco smoke are formed between 200 and 700 °C, lower temperatures would limit formation of noxious compounds (Levels of selected analytes in the emissions of "heat-not-burn" tobacco products that are relevant to assess human health risks [4]

Under this optic, it is important to understand which are the tobacco types that have negative effects in indoor areas. This paper is based on a literature review approach.

According to WHO 2000 [5] smoking is considered one of the sources of indoor air pollution together with other emissions caused by cooking or solid fuels. WHO (2000) has evaluated eighteen indoor air constituents (respirable suspended particles (RSP) < 2.5 mm

Proccedings of RTA-CSIT 2021, May 2021, Tirana, Albania
EMAIL: evadashi@ubt.edu.al

in diameter), ultraviolet particulate matter (UVPM), fluorescent particulate matter (FPM), solanesol, 3-ethenylpyridine, nicotine, 1,3-butadiene, acrylonitrile, benzene, isoprene, toluene, acetaldehyde, acrolein, crotonaldehyde, formaldehyde, carbon monoxide, nitrogen oxide, and combined oxides of nitrogen) which are determined for the quality of indoor air pollution.

2. Method

This paper was focused on reviewing several scientific articles and conference papers on the main effects in indoor air quality smoking and to direct future research in this field. This review permitted to make a comparative analysis on different scientists' opinions and research on indoor smoking effects. So, the analysis was focused on a systematic review of published papers on indoor smoking. *"A systematic review attempts to collate all empirical evidence that fits the pre-specified eligibility criteria in order to answer a specific research question. It uses explicit, systematic methods that are selected with a view to minimizing bias, thus providing more reliable findings from which conclusions can be drawn and decisions made"*[6].

The first step of the analysis was the paper's identification [7]. The papers selection was conducted by internet research and manual reading of published papers related to the relevant topic. Then I prepared a preliminary list with the potential journals I had to include in the analyze. The systematic review is linked with the use of strict criteria with the aim to produce best-quality analysis [8]. The main condition was the inclusion of peer-reviewed journals with papers written in English [7]. The second condition was paper experiment basis since it is important to have conclusions only from primary data. The third condition of the paper selection was based on WHO priority pollutants criteria for indoor areas.

As well it was eliminated duplicate titles, and titles which were clearly not related to our scope. The selected papers were 19 out of 57 relevant studies, which were considered the most appropriated corresponding to the goal of the paper.

3. The revolutionary Heat Not Burn Technology

The tobacco industry's most recent response to the documented harms of cigarette smoking was to launch new heat-not-burn (HNB) tobacco cigarettes [9]. Heat Not Burn technology is the answer of many researches and efforts to reduce the harm of smoking. One of the electronic devices that use heat not burn revolutionary technology is IQOS (I Quit Ordinary Smoking). The Heat Stick that contains the tobacco, a holder and a charger are parts of the IQOS. Tobacco Heating System IQOS heats tobacco and not burn it compared to traditional cigarettes.

4. Discussion

For many years indoor smoking cigarettes was not considered a major problem and only after 2007 EU adopted a Recommendation on Smoke-free Environments *"provide effective protection from exposure to tobacco smoke in indoor workplaces, indoor public places, public transport and, as appropriate, other public places*"[10].

A major source of indoor air pollution is considered second-hand smoke [11]. Normally, the smoking of tobacco products (especially second-hand tobacco) leads to a massive increase of particular matter (PM) in enclosed spaces [12]. Studies has demonstrated that long-term exposure to PM correlates with cardio-vascular and respiratory diseases, lung cancer, and cardiopulmonary mortality [13]

But, it is observed that environmental tobacco smoke (ETS) is one of the many sources of airborne PM in the indoor environment [14]. On the other hand, ETS is a combination of exhaled mainstream smoke (MS) and side stream smoke (SS) released from the smoldering tobacco product, and a complex mixture of chemical constituents that remains in surfaces fixed in building materials, carpets, upholstery, and furniture (third-hand smoke). [11],[15].

Indoor pollutants mainly contain organic or inorganic chemicals, biological aerosols (bioaerosols), and particles but the list is a wide range [2]. Regarding the impact of both ETS and PM on human health, only a few data are published about the concentration of PM in

ETS [11]. But we have to say that the third-hand smoking does not produce any side-stream smoke emissions, thus the potential impacts to indoor air quality from the usage of THS may come from the only exhaled aerosol [16]. Actually, it is estimated than 10% of nonsmokers' homes with smoking bans have nicotine levels higher than the average level in homes of smokers without smoking bans (>/= 30mg /m^2) [15]

On the other hand, we have to analyze smoking indoor effects of the new smoking technologies such as the Tobacco Heating System (THS).

Use of THS was reported not to increase indoor concentrations of carbon monoxide and nitrogen oxides [17], which are listed as WHO priority pollutants. Generally, the usage of THS has been associated with lower or comparable indoor air pollutant concentrations compared against other conventional indoor sources or environments, in most cases distinguishable above background, thus potentially being associated with health effects at prolonged exposure as any other artificial air pollution source [16].

On the other hand [18] found that IQOS have an impact on airways function, exhaled CO, and SaO2% of both smokers and non-smokers immediately after use, but at the same time they admit their effects on pulmonary function, short- and long-term, have not been adequately studied yet.

[19] studied that the levels of pollutants emitted by e-cigarettes and HNBT are substantially lower compared to those from TCs, the new smoking devices are still a source of indoor air pollutants. As well the nicotine yield is comparable to typical combustible cigarettes and observe substantially reduced levels of aldehydes (approximately 80–95%) and VOCs (approximately 97–99%) [4].

On the other hand, according to [20] iQOS emissions seem to be fairly clean in terms of metal emissions compared to both Conventional Cigarettes and Electronic Cigarettes. So, the concentration levels of hazardous compounds in the mainstream smoke of iQOS are much lower than those in conventional combustion cigarettes [21].

Recent studies are confirming that iQOS have a significantly lower burden of emissions for all classes of PM, including total PM emissions (all $p < 0.05$) [22], or at least modified risk in indoor smoking [23].

Results for tar and nicotine yield released from THS 2.2 has shown similar results with Conventional Cigarette, but there is found more water in THS 2.2. There are some reasons for presence of higher water in THS 2.2 compared to Conventional Cigarettes, and one of the is linked with due to the additional of glycerol and propylene glycol in the THS 2.2 heating sticks. Although most mainstream constituents of THS 2.2 are reduced compared to Conventional Cigarettes standards or 3R4F. Regulators have to pay more attention of smoking topography as a smoking machine according to the HCI-to-ISO ratio [24].

5. Future Work: IoT Based Monitoring System for Indoor Air Quality

It is very important to continuously monitor indoor air quality as the negative effects of smoking using Heat Not Burn technology and the impact on indoor environments have not yet been studied at an adequate level. Real-time monitoring of indoor air quality can reveal harmful health situations that can be resolved with human intervention. Many studies, have been conceived or designed sensor-based networks to monitor indoor air quality in real time [25, 26, 27, 28, 29]. Advances in networking, sensors, and embedded devices have made monitoring and supply of assistance possible to people in their homes [27], but not only. Based on the systematic review for indoor air quality monitoring systems based on internet of things [30] the general architecture of IoT based monitoring system presented in figure 1 provide real time monitoring of indoor air quality.

Further studies will be needed to find the best solution in terms of cost and real time monitoring of indoor air quality when people smoke with devices that use Heat Not Burn technology.

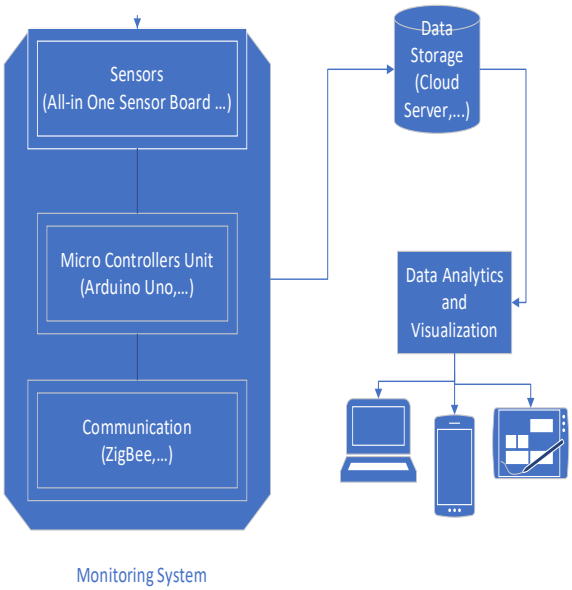

Figure 1: Architecture of IoT based monitoring system for of indoor air quality.

6. Conclusions

Tobacco smoke and THS are considered as artificial air pollution source in indoor areas. Several studies admit that the use of THS produce insignificant emissions of hazardous compound in indoor smoking. THS technology has contributed to reduce the level of the indoor smoking pollutants.

Long term health effects by THS indoor smoking have not been studied properly. On the other hand, the negative effects of THS and the impact on indoor smoking is not studied yet in an adequate level.

The toxic compounds (nicotine tar and tobacco specific nitrosamines) are not completely removed from the mainstream smoke of iQOS, making it necessary to consider the health effects and regulation of second-hand smoke widely recognized as a common issue by WHO [31].

On the other hand, scientists are suggesting that it is better to enable a smoke free environment to avoid the differences between main and passive smokers and as well to protect human health even the negative effects of heat-not-burn tobacco are not yet verified [32].

7. References

[1] WHO. Household air pollution and health. https://www.who.int/en/news-room/fact-sheets/detail/household-air-pollution-and-health (2018).

[2] Repace J.L., Lowrey A.H. Indoor Air Pollution, Tobacco Smoke, and Public Health. *Science*, Vol. 208, 2 May 1980. 0036-8075/80/0502-0464$02.00/0 Copyright. AAAS

[3] Ebisike K., Ayejuyo O.O., Sonibare J.A., Ogunkunle O.A. Ojumu T.V. Pollution Impacts of Cigarette Consumption on Indoor Air Quality in Nigeria. *Journal of Applied Sciences* 4 (4): 623-629, (2004) ISSN 1607-8926

[4] Mallock, N., Böss, L., Burk, R. et al. Levels of selected analytes in the emissions of "heat not burn" tobacco products that are relevant to assess human health risks. Arch Toxicol 92, 2145–2149. (2018). https://doi.org/10.1007/s00204-018-2215-y

[5] WHO Air Quality And Health-WHO Fact Sheet No. 313. (2011). http://www.who.int/ mediacentre/factsheets/fs313/en/

[6] Clarke M, Chalmers I. Discussion sections in reports of controlled trials published in general medical journals:

islands in search of continents? Jama. 1998;280(3):280 –2

[7] Jorgensen, M., & Shepperd, M. A systematic review of software development cost estimation studies. IEEE Transactions on Software Engineering, (2007). 33, 33–53

[8] Tranfield, D. R., Denyer, D., & Smart, P. Towards a methodology for developing evidence informed management knowledge by means of systematic review. British Journal of Management, 14(3), (2003). 207-222

[9] Letters. Heat-Not-Burn Tobacco Cigarettes: Smoke by Any Other Name. JAMA Internal Medicine Published online May 22, 2017. Downloaded From: http://archinte.jamanetwork.com/pdfaccess.ashx?url=/data/journals/intemed/0

/ by a University of California - San Diego User on 05/22/2017

[10] EU. Report on the implementation of the Council Recommendation of 30 November 2009 on Smoke-free Environments (2009/C 296/02). Brussels, 14.3.2013 SWD, 56 final/2. https://ec.europa.eu/health/sites/health/files/tobacco/docs/smoke-free_implementation_report_en.pdf

[11] Mueller, D., Uibel, S., Braun, M. Klingelhoefer D., Takemura M., Groneberg D.A. Tobacco smoke particles and indoor air quality (ToPIQ) - the protocol of a new study. *J Occup Med Toxicol 6, 35*.(2011) https://doi.org/10.1186/1745-6673-6-35

[12] Braun M., Koger F., Klingelhöfer D., Müller R., Groneberg D. A. Particulate Matter Emissions of Four Different Cigarette Types of One Popular Brand: Influence of Tobacco Strength and Additives. *Int. J. Environ. Res. Public Health*, 16, 2019 263, 1-11

[13] Gerber A. , Hofen-Hohloch A.V, Schulze J., Groneberg D.A. Tobacco smoke particles and indoor air quality (ToPIQ-II) – a modified study protocol and first result. *Journal of Occupational Medicine and Toxicology* (2015) 10:5 DOI 10.1186/s12995-015-0047-8

[14] Hunt A., Crawford J.A., Rosenbaum P.F., Abraham J.L. Levels of household particulate matter and environmental tobacco smoke exposure in the first year of life for a cohort at risk for asthma in urban Syracuse. *Environment International* 37 1196–1205. (2011)

[15] Matt G E., Quintana P. J.E., Hoh E., Zakarian J M., Dodder N G., Record R. A., Hovell M.F., Mahabee-Gittens E. M., Padilla S., Markman L., Watanabe K., Novotny Th.E. Persistent tobacco smoke residue in multiunit housing: Legacy of permissive indoor smoking policies and challenges in the implementation of smoking bans. *Preventive Medicine Reports* 18, 101088. (2020)

[16] Kauneliene V., Meisutovic-Akhtarieva M., Martuzevicius D. A review of the impacts of tobacco heating system on indoor air quality versus conventional pollution sources. Chemosphere 206 (2018) 568- 578

[17] Mitova, M.I.; Campelos, P.B.; Goujon-Ginglinger, C.G.; Maeder, S.; Mottier, N.; Rouget, E.G.R.; Tharin, M.; Tricker, A.R. Comparison of the impact of the Tobacco Heating System 2.2 and a cigarette on indoor air quality. *Regul. Toxicol. Pharmacol* (2016). 80, 91–101

[18] Pataka A., Kotoulas S., Chatzopoulos E., Grigoriou I., Sapalidis K., Kosmidis C., Vagionas A., Perdikouri E.I., Drevelegas K., Zarogoulidis P., Argyropoulou P. Acute Effects of a Heat-Not-Burn Tobacco Product on Pulmonary Function. *Medicina* 56, no. 6: 292. (2020)

[19] Savdie J., Canha N., Buitrago N., Almeida S. M. Passive Exposure to Pollutants from a New Generation of Cigarettes in Real Life Scenarios. *Int. J. Environ. Res. Public Health*, 17, 3455, 1-19 (2020)

[20] Ruprecht A. A., De Marco C., Saffari A., Pozzi P., Mazza R., Veronese C., Angellotti G., Munarini E.,. Ogliari A. C, Westerdahl D., Hasheminassab S., Shafer M. M., Schauer J. J., Repace J., Sioutas C., Boffi R. Environmental pollution and emission factors of electronic cigarettes, heat-not-burn tobacco products, and conventional cigarettes, *Aerosol Science and Technology*, 51:6, 674-684, (2017) DOI: 10.1080/02786826.2017.1300231

[21] Bekki K, Inaba Y, Uchiyama S, Kunugita N. Comparison of Chemicals in Mainstream Smoke in Heat-not-burn Tobacco and Combustion Cigarettes. J UOEH. 2017;39(3):201-207. doi: 10.7888/juoeh.39.201. PMID: 28904270.

[22] Peruzzi M., Cavarretta E., Frati G., Carnevale R., Miraldi F, Biondi-Zoccai G., Sciarretta S., Versaci F., Cammalleri V., Avino P., Protano C.

Vitali M. Comparative Indoor Pollution from Glo, Iqos, and Juul, Using Traditional Combustion Cigarettes as Benchmark: Evidence from the Randomized SUR-VAPES AIR Trial. Int. J. Environ. Res. Public Health, 17, 6029; (2020) doi:10.3390/ijerph17176029

[23] Protano C., Manigrasso M., Cammalleri V., Biondi- Zoccai G., Frati G, Avino P. Vitali M.(2020) Impact of Electronic Alternatives to Tobacco Cigarettes on Indoor Air Particular Matter Levels. Int. J. Environ. Res. Public Health, 17, 2947; (2020) doi:10.3390/ijerph17082947

[24] Li X. , Luo Y., Jiang X., Zhang H., Zhu F., Hu Sh, Hou H., Hu Q., Pang Y. Chemical Analysis and Simulated Pyrolysis of Tobacco Heating System 2.2 Compared to Conventional Cigarettes. Published by *Oxford University Press on behalf of the Society for Research on Nicotine and Tobacco*. 2018. Downloaded from https://academic.oup.com/ntr/advance-article-abstract/doi/10.1093/ntr/nty005/4793230 by University of Pennsylvania Libraries user

[25] Tsang-Chu Yu, Chung-Chih Lin, Chun-Chang Chen, Wei-Lun Lee, Ren-Guey Lee, Chao-Heng Tseng, Shi-Ping Liu, Wireless sensor networks for indoor air quality monitoring, Medical Engineering & Physics,Volume 35, Issue 2, 2013, Pages 231-235,ISSN 1350-4533, https://doi.org/10.1016/j.medengphy.2011.10.011.

[26] Schieweck, A., Uhde E., Salthammer T., Salthammer, L. C. Morawska L., Mazaheri M., Kumar P. "Smart homes and the control of indoor air quality," Renewable and Sustainable Energy Reviews, Elsevier, vol. 94(C), 2018 pages 705-718.

[27] Marques, G.; Pitarma, R. A Cost-Effective Air Quality Supervision Solution for Enhanced Living Environments through the Internet of Things. *Electronics* 2019, *8*, 170. https://doi.org/10.3390/electronics8020170

[28] Jo, J., Jo, B., Kim, J., Kim, S., & Han, W. Development of an IoT-Based indoor air quality monitoring platform. *Journal of Sensors*, *2020*, [8749764]. https://doi.org/10.1155/2020/8749764

[29] R. K. Kodali, S. Pathuri and S. C. Rajnarayanan, "Smart Indoor Air Pollution Monitoring Station," *2020 International Conference on Computer Communication and Informatics (ICCCI)*, 2020, pp. 1-5, doi: 10.1109/ICCCI48352.2020.9104080.

[30] Saini, J.; Dutta, M.; Marques, G. Indoor Air Quality Monitoring Systems Based on Internet of Things: A Systematic Review. *Int. J. Environ. Res. Public Health* 2020, *17*, 4942. https://doi.org/10.3390/ijerph17144942

[31] Bekki K., Inaba Y., Uchiyama Sh. Kunugita N., Comparison of Chemicals in Mainstream Smoke in Heat-not-burn Tobacco and Combustion Cigarettes. J UOEH 39 (3): 201-207 (2017)

[32] M. AL-Harbi. Impact of tobacco smoke on the elemental composition of indoor different particles sizes. *International Journal of Environmental Science and Technology* (2018) https://doi.org/10.1007/s13762-018-1973-7