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Aim and Scope

Quality of Life publishes original research papers and reviews and aims to provide a forum for the rapid dissemination of significant novel research in the various disciplines encompassing the Science and technology of food, Public health engineering, Sanitary inspection and control, Environmental and public health. Topics covered by the journal include:

- Dietetics; Nutrition principles applied to foods
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- Sewage; Treatment, disposal, utilization of sewage
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- Measures against industrial and other nuisances
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Contents

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Dear readers and authors,

As Editor-in-Chief of the journal Quality of Life, I look forward to the challenge of creating a journal that will enhance the quality of research in the various disciplines encompassing the Science and technology of food, Public health engineering, Sanitary inspection and control, Environmental and public health in our country, the region as well as at the international level. The journal Quality of Life was registered in the Register of Public Media in 2010 by the Decision of the RS Ministry of Education and Culture. Over the past years, this journal has published a large number of original scientific research papers, communications and review papers. Quality of Life is published twice a year by Pan-European University "Apeiron" Banja Luka. All the papers published so far have undergone a thorough review by the editorial board and the reviewers, made up of experts from both RS/B&H, the surrounding and other countries, from proven and recognized university and research institutions. As a result of a professional approach to selecting and reviewing papers, and raising the quality of the journal, Quality of Life was classified in the first category of journals in 2019 by the Ministry of Education and Culture.

We are proud to say that Quality of Life has been well received by the scientific and the general public in a relatively short period, which gives the editorial board a strong motivation for further work. The editorial team would like to thank our many reviewers who helped to maintain the journal standard; our many authors who submitted their best work to the journal; and, most importantly, our readers for your continuing support. I shall assure all our readers that our consistent efforts will be aimed toward increasing the visibility, impact, editorial cycle time, citations and overall quality of our journals. We very much look forward to strengthening the reputation of our publications, and we want to attract more higher-quality submissions.

In the spirit of continuous improvement, any constructive input on streamlining our processes is very welcome. Please help us grow by citing articles that you read in Quality of Life. We look forward to receiving your contributions in the near future.

Editors

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Original scientific paper

Assessment of Life Satisfaction Among Retired Kwara State Civil Servants Amidst Covid-19 Pandemic Lockdown

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ABSTRACT: The purpose of this study was to assess life satisfaction among retired Kwara state civil servants amidst covid-19 pandemic Lockdown. Descriptive research design of ex-post-facto type was used in the study. The study tested the retired civil servants in Kwara state, Nigeria. One hundred respondents were selected using purposive and convenient method. The respondents were measured with validated scale with 0.81 and the data obtained was analyzed, using percentage and t-test statistical tools for two research questions raised. The result showed low level of life satisfaction of retired civil servants and there was no significant difference in life satisfaction of male and female retired Kwara state civil servants (t= .07; p>0.05). In view of these findings, the study recommended that government should put retirees interest in mind and severed their basic retirement need as at when due such as gratuity and pension.

Keywords: Covid-19 Pandemic, Retirement, Life Satisfaction, and Gender.

INTRODUCTION

The world has been shocked by the outbreak of the Covid-19 pandemic. The World Health Organization (WHO) announced the outbreak of a new coronavirus (SARS-CoV-2) at the beginning of the year 2020. According to WHO, the disease was first reported in the city of Wuhan, China, in December and has since then, covid-19 spread like a wildfire to more than 190 countries. In other words, the disease has become a global pandemic. The pandemic has caused massive economic disruptions across the globe. Economic experts have predicted that the pandemic could plunge the world into a global recession (Ozili & Arun, 2020). Also, the pandemic has claimed a significant number of lives across the globe, coronavirus disease 2019 is an infectious disease that is popularly known as Covid-19.

Moore (2020) stated that coronavirus disease is caused by severe acute respiratory syndrome, its symptoms include fever, cough, shortness of breath, sore throat, runny nose, sneezing, among others. Munkarah (2020) Covid-19 is a highly communicable disease the mode of covid-19 transmission is from person-to-person transmission occurs among close contacts mostly through respiratory droplets released when the infected person sneezes or coughs while measures such as lockdown, social distancing, self-isolation or self-quarantine and observation of simple hygiene habits such as regular washing of hands, wearing of facemasks and covering the mouth with a handkerchief when coughing or sneezing have been recommended to contain the spread of the disease among people. It is important to note that there was no any known cure or vaccine for the Covid-19 pandemic before 2020 after which effort has been made in introducing Vaccine. Nevertheless, different countries and international organizations like WHO have developed vaccines or drugs for the Covid-19 disease.

Retirement is seen by Willaims (2017) as the complete or partial disengagement from work or a given occupation or social life. While, Athley (2018) defines retirement as a process that separates a worker from his or her job role, Nwajagu (2017) sees retirement as withdrawal or giving up office or work through

voluntary, compulsory and mandatory format. Whatever means it occurs; it is a transition from phase of work life to another phase of leisure activities which may not be paid for. Retirees are faced with several issues before and during pandemic lockdown in their retirement life. Several scholars have identified some eminent issues confronting retirees daily in life events, which some considered life threatening.

Oniye (2001) indicated that retirement is a complex life events that demand careful planning. He identified some areas of challenges. They are lack of understanding, financial problems, social stigma and health constraints. Similarly, Kolawole and Mallum (2004) opined that retirees often experienced challenges in the following life events insufficient financial resources, problem of securing residential accommodation, the challenge of a new and low social status and challenges of declining health.

Also, Okechukwu and Ugwu (2019) concluded that in Nigeria, the delay in payment of pension and gratuities often lead to hardship and death in some circumstances, making retirement dreaded venture. In addition, Anieto (2021) vividly indicated that pensioners are owed several months of pension arrears with little or no hope for immediate payment. However, Nigeria retirees according to Fapohunda (2021) have to struggle and suffer significantly before they could collect their meagre benefits. In view of this suffering larger number of retired workers could not make any tangible things from their benefits. Inadvertently, this has made retirement stress real and inescapable in the context of Nigeria public service and a nightmare for active public servants who are on the verge of retirement.

Shittu (2020) Stated that total sum of N11billion is currently being owed as gratuities to the Kwara State pensioners from previous years, just as the concerned pensioners in the state have said about 500 people have lost their lives due to non-payment of gratuity in the state. Arogundade (2020) opinion that retirees in Nigeria are generally faced with poor wellbeing, this contributes to reasons almost every workers has a personal concern about retirement.

Life satisfaction is an assessment of life as a whole based on how well personal goals match with personal achievements (Glass, 2019). It is a subjective and general estimation of physical, social and psychological aspects of an individual's current life situation (Budh and Osteraker, 2017). Satisfaction with one's life implies contentment with or acceptance of one's life circumstances or the fulfillment of one's wants and needs for one's life as a whole. Heybroek (2021) investigated the variation in life satisfaction after retirement in Australia and the associated individual characteristics. In their study, they established declines in levels of life satisfaction among retirees and noted that those who experienced significant decline often suffer poor health.

In Nigeria, Ejechi and Ogege (2020) estimated that about 51.1 percent of the Nigerian retirees sampled were experiencing unsatisfactory quality of life and that socio-demographic variables such as education, living with spouse, age, year of retirement, socio-economic status are possible correlates of life satisfaction among retirees. However, much emphasis has not been made on gender variable particularly in the period of covid-19 pandemic lockdown. It is pertinent to understand life satisfaction and its influencing factors among retirees in Nigeria. This is because findings from such studies would give ideas to organizations, government and policymakers on how retirees could live and enjoy their lives in retirement through recommended intervention programs. For the purpose of this study gender waslooked as correlate with life satisfaction of retirees.

Gender refers to the socially constructed characteristics of women and men, such as norms, roles and relationships of and between groups of women and men. It varies from society to society and can be changed, gender was considered and employed as a possible influencing demographic variable to life satisfaction among retirees. Some studies have noted that men have more tendencies than women to save or engage in several financial investments as preparation toward retirement (Glass and Kilpatrick, 2018).

These differences may be attributed to many factors and more importantly, the disparity between the tendencies for both sexes to engage in financial investments after retiring from work is vice versa. There have been mixed reports on issues of differences in life satisfaction of male and female retirees across the globe.

However, most of the previous studies indicated no significant gender difference in life satisfaction of retirees (Saeed and Bokharey 2020). The trend of argument of these previous studies was that certain factors such as life events and experience, style of life and self-esteem among others, could moderate the influence of gender on life satisfaction in population of retirees among Kwara state retired civil servants amidst covid-19 pandemic lockdown.

Purpose of the Study

The main purpose of this study is to assess life satisfaction among retired Kwara State civil servants amidst covid-19 pandemic lockdown:

1. To assess the level of life satisfaction of retired Kwara state civil servants amidst covid-19 pandemic Lockdown.
2. To examine gender difference in life satisfaction among retirees in Kwara state.

Research Questions

1. What is the level of life satisfaction among retired Kwara state civil servants amidst covid-19 pandemic lockdown?
2. What is the difference in life satisfaction of male and female retirees in Kwara state amidst covid-19 pandemic lockdown?

METHODOLOGY

The research design for this study was a descriptive survey research design of *ex-post- facto type*. This approach does not involve manipulation of variables in the study. It is therefore, after the fact study. It neither add to nor deduct from the existing fact. The population of this study covered the entire retirees in Kwara state, Nigeria. Purposive and convenient method were used, purposive in the sense that only one-hundred retired teachers were used and convenient because only those who are ready to fill the instrument were selected. The instrument developed by Amaike & Olurode (2014) was adapted for the study to measure the life satisfaction of retired civil servants. The instrument was however checked by the expert in Counselling Psychology and Educational Evaluation, Al-Hikmah University Ilorin, Nigeria for validity and administered to the group of retired civil servants in Oyo State to determine the reliability of the instrument for cultural compliance. The split half method was used in the pilot tested copy of the instrument and 0.81 correlation coefficient was obtained.

The instrument was administered to the respondents, on their meeting day. The researcher was assisted by two trained research assistants in the administration and collection of instruments were done on the same day. The 100 instrument administered was retrieved completely. The data collected from the study was analyzed using percentage and t-test statistical method at 0.05 level of significance. The response format was placed on strongly agree, agree, disagree and strongly disagree. The positive items were graded as 4 for strongly agree, 3 for agree, 2 for disagree and 1 for strongly disagree while the negative items were reversed and graded as positive items were graded as 1 for strongly agree, 2 for agree, 3 for disagree and 4 for strongly disagree. The overall mean for each item is calculated as sum of the points as 4+3+2+1=10 divided by the number of points which 4. Hence, 10/4 which gives the limit point of 2.5. Then, the score below the limit point showed low level of life satisfaction while the score above the limit point revealed

high level of life satisfaction. Also, the sum of the mean of over all items revealed the grand mean and divided by the number of items which 10. Then, the Average Grand mean was obtained by dividing the sum of mean by the number of items.

Also, the t-test is used to establish the difference in the male and female life satisfaction. The direction of the differences is further revealed from the mean scores of each group. This is obtained from the sum of all the points in each of the items where positive items were graded as 4 for strongly agree, 3 for agree, 2 for disagree and 1 for strongly disagree while the negative items were reversed and graded as positive items were graded as 1 for strongly agree, 2 for agree, 3 for disagree and 4 for strongly disagree. The sum of each respondent is sum up to get the identity of male and female scores on the life satisfaction. The higher mean revealed the group with high life satisfaction while the group with the lower mean revealed the group with low life satisfaction.

RESULTS

Research Question One: What is the level of life satisfaction among retired Kwara state civil servants amidst covid-19 pandemic lockdown?

Data presented in Table 1 shows that all items on life satisfaction identified had mean rating between 2.75 and 1.15 which are below the cut-off point average of 2.50 with a grand mean of 1.98 which fall at very low required response option. This result showed that all ten life satisfaction level are identified as low required by retired Kwara state civil servants amidst covid-19 pandemic lockdown. The value of standard deviation which ranges from 1.63 – 0.74 showed that respondents were homogeneous in their opinion on life satisfaction among retired Kwara state civil servants amidst covid-19 pandemic lockdown. It could inferred that the level of life satisfaction among retired civil servants amidst covid-19 pandemic lockdown was low.

Table 1: Mean ratings and standard deviations on life satisfaction among retired Kwara state civil servants amidst covid-19 pandemic lockdown

S/N	ITEMS	Mean	SD	Remarks
1	I have peace of mind in my family most especially during the Covid-19 pandemic lockdown	1.85	1.48	Low
2	I experience more satisfaction with my wife in the period of pandemic lockdown	1.80	1.51	Low
3	My family responsibility is smoothly neither stop no affected even with Covid-19 pandemic lockdown.	2.15	1.50	Low
4	I am fulfilled in marriage, even with the situation of Covid-19 pandemic lockdown.	1.15	0.74	Low
5	I became more active in term of religion during the time of Covid-19 pandemic lockdown	2.40	1.74	Low
6	When I am feeling miserable, thinking about God helps to cheer me up	2.10	1.30	Low
7	Prayer lifts my spirits even with the adventure of Covid-19 pandemic lockdown	1.69	1.46	Low
8	When I feel lonely, there are several people I can talk to	2.40	1.49	Low
9	There is no one that I feel comfortable with to talking about Intimate personal problem	1.50	1.50	Low
10	I feel like I am not always included by my circle of friends	2.75	1.63	Moderate
	Grand Average Mean	1.98	1.44	LOW

Research Question Two: What is the difference in life satisfaction of male and female retired Kwara state civil servants amidst covid-19 pandemic lockdown?

The data in Table 2 revealed that there are 36 male and 64 female retired Kwara state civil servants respectively. Male participants had slightly higher mean ($\bar{X}$ = 28.71; SD = 14.61) than female participants ($\bar{X}$ = 27.96; SD = 14.57) but the difference was not statistically significant. The Table revealed that there was no significant difference between the mean responses of male and female retired Kwara state civil servants amidst covid-19 pandemic lockdown (t_{98} = 0.07, P>0.05). Therefore, the hypothesis that stated that there is no significant difference in the mean responses of male and female retired Kwara state civil servants amidst covid-19 pandemic lockdown was accepted. This indicated that male and female retirees in Kwara state did not differ statistically significantly in their responses regarding the life satisfaction. This further meant that gender has no significant difference in terms of life satisfaction among retired Kwara state civil servants amidst covid-19 pandemic lockdown.

Table 2: Summary of t-test on the difference between the mean ratings of male and female retired Kwara state civil servants

Group	N	Mean	SD	t-cal	Df	p-value	Decision
Male	36	28.71	14.61				
				0.07	98	0.61	NS
Female	64	27.96	14.57				

Significant at p<0.05

Discussion of Findings

The result of the first research question showed that the level of life satisfaction of retirees in Kwara state was low. This is in line with finding of Fapohunda (2021) who found that retirees have to struggle and suffer significantly before they could collect their meagre benefits. In view of this suffering larger number of retired workers could not make any tangible things from their benefits. Inadvertently, this has made retirement suffering real and inescapable in the context of Nigeria public service and a nightmare for active public servants who are on the verge of retirement.

Heybroek (2021) investigated the variation in life satisfaction after retirement in Australia and the associated individual characteristics. The study established declines in levels of life satisfaction among retirees and noted that those who experienced significant decline often suffer poor health. Also, Okechukwu and Ugwu (2019) concluded that in Nigeria, the delay in payment of pension and gratuities often lead to hardship and death in some circumstances, making retirement dreaded venture. Finding on life satisfaction have shown that retirees in Kwara state were not basically satisfy.

The result of the second research question showed that there is no significant difference in life satisfaction of male and female retirees in Kwara state amidst covid-19 pandemic lockdown. This is in line with the findings of Saeed and Bokharey (2020) who stated that disparity of gender could not determine satisfaction with once life. However, certain factors such as life events and experience, style of life and self-esteem among others, could moderate the influence of gender on life satisfaction in population of retirees.

CONCLUSION

The covid-19 pandemic lockdown has limited how civil servants engaged with daily activities, given the need to reduce the outbreak by working at home, physical distancing and sheltering in place.

These limitations have a direct impact on the ability to enact purposeful activities, and without this life engagement, to feel a sense of direction to our lives. This work paid attention on how Covid-19 pandemic lockdown is impacting life satisfaction of retired Kwara state civil servant and the level of life satisfaction of male and female retirees. From the findings of this study, it was evident that retirees in Kwara state were not enjoying their retirement life, on the fact that retirement presented financial and social challenges. In this wise, lack of access to gratuity and pension became source of worry and particularly during the covid-19 pandemic lockdown.

Recommendations

Having gone through the study the following recommendation were therefore highlighted for consideration by state government pension management board, retirees and counsellor as follows:

1. Government and educational stakeholders should set up retirees assistance counselling and welfare programmes in other to improve on the life satisfaction of retired civil servants in the country.
2. In irrespective of gender differences government should always assist retirees in payment of their gratuity and pension regularly.

REFERENCES

Adewuyi, T.D.O. (2019). *Plan for your Retirement*: Ijanikin L.G: Acts systems

Amaike, B. andOlurode, L. (2014). Gender differentials in retirement antecedents and life satisfaction of formal sector retirees in Lagos State, Nigeria. *The Journal of Aging in Emerging Economies, 68-99.*

Anieto, U.O. (2021). *Retirement in Nigeria: Relish or Anguish*? hittp://www.focusnigeria.com/retirement-nigeria.

Arogundade, O. T. (2020) Late Career Work Disengagement and Thriving at Work as Predictors of Pre-Retirement Anxiety among Nigerian Nurses. *Nigeria Journal of Psychological Research 16 (2), 20-28.*

Athley, A. (2018). *The Sociology of Retirement*. Cambridge Mass: Schenkman publishing company Inc.

Canda, E.R. and Furman, L.D. (2010) Spiritual Diversity in Social WorkPractice: *The Journal of Religion and Spirituality in Social Work, 24(1/2): 93–110***.**

Diener, E, Emmons R.A., Larsen R.J. and Griffin S. (1985). The satisfaction with life scale*. Journal of Personality Assessment, 49(1): 71-75.*

Ejechi, E.O. andOgege, S. O. (2020). Quality of Life of Female Public Service in Nigerian setting. *Journal of Social and Management Science 11(1); 62-71.*

Finogenow, M. (2021). Personality traits and subjective health in retirement age: *The role of personal resources. Polish Psychological Bulletin, 44(2): 213222.*

Fapohunda T. M. (2021). The Pension System and Retirement Planning in Nigeria*. Mediterranean journal of social sciences, 4(2). doi: 10, 5901/miss.2021.v4n2p25*

Heybroek, L. (2021). Life Satisfaction and Retirement in Australia: *A Longitudinal Approach to Work, Aging and Retirement 1 (2), 166-180*

Kolawole, S. A. and Mallum, A.Y. (2004). *Retirement Counselling Association of Nigeria* (CASSON), Maiduguri, Nigeria

Moore, J.T. (2020). *Therapeutics to treat and attenuate ARDS secondary to COVID-19. Journal of Trauma and Acute Care Surgery, 88 - Issue 6-34-35*

Munkarah, A. (2020). The Epidemiology and Pathogenesis of Coronavirus (COVID-19) outbreak. *Journal of autoimmunity, 102-133*

Nwajagu, C.I. (2017*). Procedure for processing of retirement benefits and computation.* An unpublished seminar paper submitted to the Department of public Administration and Local Government, Faculty Social Science, University of Abuja

Okechukwu, E. I and Ugwu, S.C. (2019). The laws and Administration of retirement in Nigeria: *A historical approach. Ruwait chapter, Arabian Journal of Business and management Review, Vol (1)2, 1-10.*

Oniye, A.O. (2021). Retirement stress and management strategies among Retired Civil Servants in Kwara State: *Counselling implication and interventions. Retrieved from www.docstoc.com/docs/4905722/RE-EN*

Ozili, P. K. and Arun, T. (2020). Covid-19 in Africa Social-economic impact, Policy-Response and Opportunities*. International Journal of Sociology and Social Policy, 3 (4), 63-71*

Saeed, F. and Bokharey, I. Z. (2020). Gender differences, life satisfaction, and its correlate and death anxiety in retirement. *Journal of Psychology and Clinical Psychiatry,* 5(2): 28-40.

Williams, S. A. (2018). *Reluctance of Retire*: *a qualitative study on work identity, intergenerational conflict and retirement in academic medicine. Retrieved from www.google.com/23analysis 21/01/2020*

World Health Organization, WHO. (2020). The deadly Coronaviruses: *The 2021 SARS pandemic and the 2020 novel coronavirus epidemic in China. Retrieved from www.google.com/23analysis 21/01/2020*

Wuhan Institute of Virology. (2020). *Discovery of a Novel Coronavirus Associated with the recent pneumonia outbreak in humans and its potential bat origin. Retrieved from www.google.com/23analysis 21/01/2020*

Appendix

Section A: Demographic Data

Age: Below 50 years ( ) 50 and above ( )

Religion: Christianity ( ) Islam ( ) Traditional ( )

Gender: Male ( ) Female ( )

Section B: Life Satisfaction Scale

S/N	ITEMS	SA	A	D	SD
1	I have peace of mind in my family most especially during the Covid-19 pandemic lockdown				
2	I experience more satisfaction with my wife in the period of pandemic lockdown				
3	My family responsibility is smoothly neither stop no affected even with Covid-19 pandemic lockdown.				
4	I am fulfilled in marriage, even with the situation of Covid-19 pandemic lockdown.				
5	I became more active in term of religion during the time of Covid-19 pandemic lockdown				
6	When I am feeling miserable, thinking about God helps to cheer me up				
7	Prayer lifts my spirits even with the adventure of Covid-19 pandemic lockdown				
8	When I feel lonely, there are several people I can talk to				
9	There is no one that I feel comfortable with to talking about Intimate personal problem				
10	I feel like I am not always included by my circle of friends				

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Original scientific paper

Youths Quality of Life in Nigerian State: Link With Resilience, Locus of Control and Perceived Social Supports?

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ABSTRACT: Cross sectional research design was adopted to examine the relationship between three independent factors (resilience, internal locus of control, perceived social supports) and qaulity of life. A sample size of four hundred (400) youths between ages 18-30 years (Male=240; Female=160) were selected using a combination of simple random sampling and purposive technique from a population of out-of school youths in Anambra State, Nigeria. Four standardized scales were used for data collection. Pearson Product Moment Correlation (PPMC) and Multiple Regression were used for data analysis. Findings revealed that resililence (r= 0. 146**p<.05), internal locus of control (r= 0. 165** p<.05) and social support (r= 0. 658** p<.05) positively correlated with quality of life respectively. There was significant joint contribution of the independent variables to the prediction of quality of life among the respondents F (5,395) = 102.299, P<0.001). The independent variables (resilience, internal locus of control and perceived social supports) when combined accounted for 50.2% (Adj.R2= .502) of the variance in quality of life among out-of school youths in Anambra State. Resilience was the most potent predictor of quality of life among the variables considered in this study (β =.591, t =10.153, P<0.001). Counselling psychologists should institute resilience-focused therapy to build the practical skills of youths to become capable of handling their everyday challenges in order to have an improved quality of life.

Keywords: Locus of control, social-support, quality- of -life, resilience, youths.

INTRODUCTION

Nigeria in recent times has witnessed an unprecedented level of insecurity manifested in bombing, kidnapping, hostage taking, destruction of properties and other societal problems that has the potential to disrupt an individuals quality of life. Quality of life in this study is conceptualised as anyone 's perception of his or her position in life in the context of the culture in which they live and in relation to their goals, expectations, standards and concerns (World Health Organisation, 2012). Good quality of life is important at every stage of one's life, from childhood and adolescence through adulthood. Little wonder that United Nations Children's Fund (UNICEF) declare that children and youths should have at least mimimum good quality of life which includes the rights and freedoms of all human beings, including adequate nutrition, health care, and education, as well as freedom from abuse, violence, and exploitation (United Nations International Children's Emergency Fund., 2019).

Regrettably, a group that may not enjoy the minimum quality of life is out-of- school youths in Anambra State. The reason is not far fetched. The well reported crisis in that state in recent time involving Indigenous People of Biafra (IPOB) comprising majorly out-of- school youths between 18-30 years old is capable of causing upheaval to their quality of life. These youths for the past six years have actively been involved in the agitation for a Biafra Nation along with other youths in South-East, South-South and some parts of the Middle Belt States of Nigeria (Ibeanu, Iwuamadi & Nkwachukwu, 2016). In view of the foregoing, there has been regular protesters and police clashes which has been ongoing since 2014 (Ibeanu, et al., 2016).

Researchers from various fields of study—developmental psychology, sociology, economics, public policy, demography, and family studies—have independently shown that insecurity, crisis, violence and turbulent situation are associated with poor quality of life (Baptista, Rodrigues, Gregório, de Sousa, Cruz, & Canhão, 2018: Mester, Bugnar, & Andreea, 2011). More worrisome is that Anambra State has is reported to have 118,314 (15 per cent) out of the estimated 10.2 children and youths who are of schools in Nigeria. (National Bureau of Statistics, 2020), The relationship between being educated and quality of life cannot be over emphasized. It is documented that education leads to better lifestyle choices, improves skills and enable an individual to have an effective habits (Vayachuta1a, et al., 2016). Being out –of school could lead to other bigger issues, such as crime and labour skills problems. A study for example, reveal that 'out-of-school' youths are 7 times more likely to put themselves at risk than youths in school and even live a shorter life span than youths in school (Vayachuta1a et al, 2016).

A plethora of studies have been conducted to investigate the construct of quality of life. However, a concern is that majority of these studies targeted adults, children and youths with chronic illneses (Baptista, et al., 2018: Gil-Lacruz., Gil-Lacruz, & Gracia-Pérez, 2020). For stakeholders to tailor intervention to suit target there is need to obtain empirical data on factors that are associated with quality of life among population without any chronic conditions or disabilities. It therefore becomes imperative to examine the relationship between three independent factors (resilience, internal locus of control, perceived social supports) and qaulity of life.

LITRATURE REVIEW

Literature suggest that resilience has the potential to be used as a defensive measure towards any condition that disrupts an individuals homeostasis (Stainton, et. al, 2019). Pardeller, Kemmler, Hoertnagl and Hofer (2020) define resilience as the process of adapting well in the face of adversity, trauma, tragedy, threats, or significant sources of stress. Resilient people are said to make use of individual and social resources to overcome adversity, while non resileint individuals are often overwhelmed by difficult or stressful situations, dwells on problems or use unhealthy mechanisms to cope with challenges of life (Laird, Lavretsky, Paholpak, Vlasova & Roman, 2019). A concern is that the relationship between resilience and quality of life is yet to be fully explored.

Locus of control is an area of individual differences suggested by Attribution theory to have the potency to be associated with quality of life (Weiner,1986). Attribution is a term used in psychology to describe how individuals perceive the causes of their everyday experiences, as being either external or internal. Locus of control is one of the four well researched dimensions of core self-evaluations, along with neurotiscim, self-efficacy and self esteem (McAnena, Craissati, & Southgate, 2016). Rotter (1954) define locus of control as the degree to which people believe that they, as opposed to external forces (beyond their influence), have control over the outcome of events in their lives. A person's is conceptualized as internal (a belief that one can control one's own life) or external (a belief that life is controlled by outside factors which the person cannot influence, or that chance or fate controls their lives). Individuals with external locus of conrol has ben reported to be more vulnerable to stress and poor health. This is unlike their counterpart with internal locus of control who has better help-seeking and low level of stress (Reknes, Visockaite., Liefooghe, Lovakov & Einarsen, 2019; Hussain, Baqir, Islam & Asif, 2020). There is ongoing debate concerning the relationship between internal locus of control and quality of life.

Another variable that could be associated with quaility of life is perceived social supports. Perceived social support refers to how individuals perceive friends, family members and others as sources available to provide material, psychological and overall support during times of need. It is documented that more social

support is associated with higher levels of subjectively perceived quality of life. There is preliminary evidence to suggest that perceived social support is related to an individuals quality of life (Kassianos, Symeou & Ioannou, 2019; Zdun-Ryżewska, et al., 2018). They argue that when individual feels that they have a levels of support, love, and care it will enable them to have positive life experiences.

Purpose of the study

The broad purpose of this study is to investigate if the quality of life of youths is associated with resilience, locus of control and perceived social supports. Specifically, the study proffered answers to the underlisted hypotheses.

Hypotheses

The following research questions were formulated to guide this study.

H_1. There is no significant relationship between the independent variables (resilience, internal locus of control, perceived social supports) and quality of life among youths in Anambra State, Nigeria.

H_2. There was no significant joint and relative contribution of the independent variables (resilience, internal locus of control and perceived social supports) to prediction of quality of life among out-of-school youths in Anambra State, Nigeria.

MATERIALS AND METHODS

Cross sectional design was adopted for this study. A sample size of four hundred out-of -school youths were randomly sampled from three towns in Anambra State. These three towns (Onitsha, Nnewi and Awka) are noted for violence during the IPOB crisis in Anambra State, Nigeria. The respondents comprised out-of school youths drawn from traders, barbers, catherers, tailors, drivers and road transport workers.

Measures

Four instruments were serialized into one document. It has sections A, B, C, D. and E

Section A was used to collect information about the demographic profile of the respondents (age, gender, sources of livelhood, educational status). The details of sections B, C, D and E are provided thus;

Section B: Youth Quality of Life

Youth Quality of Life - Short Form (YQOL-SF) by Patrick, Edwards and Topolski (2002) was used to asees the ouths quality of life. This questionnaire measures generic quality of life without any chronic conditions or disabilities. The instrument has 15 self-report items measuring the 4 domains each, namely: sense of self, social relationships, environment, and general quality of life. Typical items on the instrument includes*: "I keep trying, even if at first I do not succeed", "I feel good about myself".* The response pattern ranges from 0 = not at all to 10 = a great deal or completely. However, for the purpose of this study, the Likert version was modfied to 5-1 (strongly agree to strongly disagree). The instrument was admistered in approximately 10 minutes. Thereafter, the scores were summed and transformed to a 0 to 100 scale, a higher score represents a higher quality of life. The authors reported satisfactory internal consistency (Cronbach's alpha) of 0.80 for all the four domains (Patrick et. al., 2002). While the intraclass correlation coefficients for each domain were as follows; self (0.85), social (0.85), environment (0.76), general QOL (0.74), and total score (0.78) (Patrick et. al., 2002). This instrument was revalidated on 30 youths randomly drawn from Imo State- a neigbouring state with similar IPOB issue. Test- retest-relaibility coefficient of r=0.82was obtained which was considered good for this study (Weir, 2005).

Section C: Brief Resilience Scale (BRS)

Brief Resilience Scale (BRS) by Smith,Dalen, Wiggins, Tooley, Christopher and Bernard (2008) was used to assess the youths resilience. It is a six item self-rating questionnaire aimed at measuring an individuals' ability to "bounce back from adversity." This instrument was originally developed to provide some key insights for individuals exposed to health-related stress (Smith, et al., 2008). Of the six items, three were positively worded while the other three were negatively worded . It was designed in Liket format of strongly Agree to strongly disagree on a scale of 5 4 3 2 1. Typical items include: "*I tend to bounce back quickly after hard times"*, "*I have a hard time making it through stressful events"*. It took approximately five minutes to administer the questionniare. The Scoring is easy, it was done by simply adding the responses varying from 1-5 for all six items giving a range from 6-30 and divide the total sum by the total number of questions answered. Windle et al. (2011) reported that BRS is a highly valid and reliable measure of resilience in its most basic and core form unlike the other resilience scales that measure personal characteristics. He added that BRS has Cronbach's alpha of .8 or over in all the studies testing its psychometric validity. Test- retest-reliability coefficient of r=0.84 was obtained during pilot study. This made the researcher to conclude that the instrument was stable to measuer the construct.

Section D: Locus of control Measure

Twenty-three items self-report scale deveolped and validated by Suárez – Álvarez, et al. (2016) was used to assess the youths locus of control. The instrumen has two subscales, namely external locus of control (13 items) and internal locus of control (10). For the purpose of this study, only the items on internal locus of control was used because it suit the purpose of the study. Sample items on the internal locus of conrol includes: "*Success depends on my effort" "What I have, depends on the effort that I make to get it" "My future depends on what I do*". This section on internal locus of control has internal relaibilty index of α=.85.

Section E: Social Support Scale measure

The respondents perceived social support was measured on a four-point Likert scale developed by Zimet et al. (1988). The scale projected the measurement of how one received various means of supports from friends, well wishers and relatives in respective of their situations in life. The higher scores on this measure indicate greater social support that the individual enjoys. Typical items one the scale include: *Most of my friends are more successful at making changes in their lives than I am*", "*There is someone I can turn to for advice about handling problems with my family"*Prior studies have reported Cronbach's alpha coefficients for the PSSS from 0.86 to 0.93. The scale however, was pilot-tested to align with the cultural context in Nigeria and it yielded a correlation coeffcient of r = 0.84.

Procedure

This study was carried out between May-July,2021 which coincide with the period of heightened violence in Anambra state due to the court case of a proclaimed IPOB leader as well as preparation for the 2021 gubernatorial elction. Youths were randomly sampled from three major cities in Anambra State (Onitsha, Awka and Nnewi). The youths were approached in their various locations(shops, centres, shade etc). The researcher informed the partcipants that the study was needed as an evidence to direct the government's attention to cater for their qaulity of life. They were encouraged to seek clarifications if there is any item or items they do not understand. The researcher used their local language (igbo langauge) to give the instruction. Two Research Assistants who had partcipated in data collection in a previous study conducted by Ofole (2016) supported in the administration of the questionnaires. The respondents were given the op-

tion to *opt out* if they were not willing to respond or got tired of responding to the items provided. Of the five hundred and twenty (520) questionnaire distributed, only four hundred(400) were correctily fiiled. As a result, the qustionnaire return rate was 77%.

Method of Data Analysis

Descriptive staitistcis (frequency count and percentages) was used to analyse the demographic information of the respondents. While the inferential statistics were Pearson Product Moment Correlation (PPMC). The PPMC was used to test the relationship between the independent variables and the dependent variables. Multiple regression analysis was used to analyse the joint and relative contribution of the independent variables to the prediction of quality of life. level of significance adopetd was 0.05 apha level. The results are displayed on Tables 1-3.

RESULTS AND DISCUSSION

Demographic Profile of the respondents

The results obtained from Section A of the questionnaire was summarized in Table 1.

Table 1: showing the Demographic Characteristics of Respondents

S/N	Variable	N=400	Percentage (%)
1	Gender		
	Female	160	40.0
	Male	240	60.0
2	Age Range		
	18-20yrs	115	29.0
	21-23yrs	180	45.0
	24-26yrs	65	16.0
	27-30yrs	40	10.0
3	Educational Status		
	Primaryschool leaving certificate (FLSC)	63	15.8
	Secondary school certificate (O' level)	109	27.2
	Primary school drop out	58	14.5
	Secondary school drop out	170	42.5
4	Source of Livelihood		
	Barbing	26	6.5
	Driving (motorcycle, buses, cars, Tricycle)	122	30.5
	Trading	87	21.8
	Road Transport Worker (NURTW)	89	22.3
	Tailoring	27	6.7
	Hair dressing	21	5.2
	catering	28	7.0
	Others (Contractor, Musician, Artist etc)		
5	Relationship Status		
	Married	45	11.2
	Single	289	72.3
	Engaged	66	16.5

Table 1 reveals that out of 400 respondents, 240 representing 60% were males, while 160 (40%) were females. This implies that majority of the respondents were males. Further, the catergorization of the respondents based on their age shows that those between ages 18-20 years were 115 (29%), 21-23 years (180) representing 45%. Finally, 24-26 and 27 -30 years were 16 % and 10 % respectively. Based on this, one can conclude that majority of the youths in this study were in ages 21-23 years (180). With respect to educational status, those who dropped out of secondary school were majority (42.5%), followed by those who completed secondary schools (27.2%) and primary school leaving certificate holders (15.8%). The later were slightly higher than those who dropped out of primary schools (14.5%). The possible reason for this low educational status could be due to sampled population. Table 1 reveals their sources of livelihood which has been ranked are as follows: driving (30.5%), road transport workers (22.3%), trading (21.8%), catering (7%), tailoring, (6.7), barbing (6.5%) and hair dressing (5.2%). Moreover, the Table also shows that 289 representing 72.3 % of the study population were single, while sixty-six (16.5%) were engaged. However, only 45 (11.2%) were married as at the time of conducting this study.

Hypothesis One: Hypothesis one predicted no significant relationship between the indepednt variables (resilience, internal locus of control and perceived social supports) and quality of life among out of school youths in Anambra State, Nigeria. This hypothesis was anaylsed with PPMC and the result is presented on Table 2.

Table 2: Correlation matrix showing the relationship between independent variables and Quality of life

Variables	Mean	Std.Dev	1	2	3	4	5
Quality of life	32.29	7.52110	1.000				
Resilience	2.33	.64210	.146**	1.000			
Internal locus of control	28.23	7.06772	.165**	.043	1.000		
Perceived Social Supports	25.19	9.51741	.658**	.104	.080	1.000	

*Correlation is significant at 0.05 (2-tailed)

The result obtained from this study revealed that there was a positive significant relationship between the independent variables (resilience, internal locus of control and perceived social supports) and quality of life. The null hypothesis was therefore, rejected. Findings further revealed that; resilience (r= 0. 146**p<.05), internal locus of contol (r= 0. 165** p<.05) and social support (r= 0. 658** p<.05) positively correlated with quality of life respectively. The Pearson Correlation Coefficient value of + . 146**. 165** and. 658**means that there was positive correlation among resilience, locus of control, perceived local supports and quality of life at varing degrees. This finding suggests that the three factors considered in this study (resilience, internal locus of control and perceived social supports) can explain the quality of life among the respondents but at moderate level. If youths have resilience, internal locus of control and social supports their quality of life will be satisfactory.

Question Two: The second hypothesis stated that the independent variables (resilience, internal locus of control, perceived social supports) either singly or in combination will not significantly predict the quality of life among youths in Anambra State, Nigeria. The result obtained for this hypothsis was presented on Table 3.

Table 3: Association of resilience, internal locus of control and perceived social support on quality of life

Predictors	β	t	P	R	R^2 F P
Resilience	.591	10.153	<0.05		
Internal Locus of control	.051	1.659	<0.05		
Perceived Social Support	.224	4.363	<0.05	.713	.509 102.29 <0.05

The regression analysis shows that there was a significant combined effect of the independent variables (resilience, internal locus of control and perceived social supports) to the prediction of quality of life among out-of-school youths in Anambra State, $F_{(5,395)} = 102.299$, P<0.001). Since the calculated value was higher than the t-value, the H_o was therefore rejected. The outcome also yielded a coefficient of multiple regressions R= 0.713, multiple $R^2 = 0.509$ and Adjusted $R^2 = .502$. This result suggest that the three predictor variables when combined accounted for 50.2% (Adj.R^2= .502) variance in the prediction of quality of life among youths in Anambra State while other factors not examined in this study accounted for the 49.8 %.

Furthermore, Table 3 reveals the result obtained for hypothesis three. suggest that each of the three variables (resilience, internal locus of control, and perceived social support) has significant relative contributions to the predictors of quality of life among youths in Anambra State. In terms of magnitude the most potent factor was resilience (β = .591, t = 10.153, P<0.001), followed by social support (β = -224, t = 4.363, P<0.000). Internal locus of control (β = .051; t = 4.659; P<0.05) made the least contribution to the prediction of quality of life among the youths in Anambra State, Nigeria. The implication of this finding is that the first two variables (resilience and locus of control) should be prioritized when instituting an intervention to improve youths' quality of life in Anambra State, Nigeria.

DISCUSSION

This study investigated the relationship between three predictor variables (resilience, internal locus of control, perceived social support) and quality of life among out-of school youths in Anambra State, Nigeria. The results displayed on Tables 2-3 show that there was positive relationship between resilience and quality of life. The implication of this finding is that the more the youth is resilent, the greater the likelihood that he/she can cope successfully with adversities in his or her environment. This finding corroborates with large body of evidence who reported that being resilience led to successful adaptation and unfolding of tolerance within a context of debilitating adversity or stressful events (Laird, et al., 2019; Temprado Albalat, García Martínez, Ballester Arnal, & Collado-Boira, 2020: Pardeller etal., 2020). This outcome gives credence to the theroretical framework of Greene, Galambos and Lee (2004) who argue that it is not the nature of the adversity that is most important in coping but rather how one deals with it and other misfortunes or frustrations of life.

The finding from this study also suggest that perceived social support was associated with quality of life among the youths. This concurs with previous studies (Zdun-Ryżewska, et al. 2018; Moghadam et al. 2020) who reported that those who received social supports from friends, relations and well wishers during hospitalization recovered faster than those who did not receive. Similarly, scholars (Deniz Şahin, Özlem & Özer: Melek Zubaroğlu & Yanardağ, 2019) reported positive relationship between perceived social support in people aged 65 years and their quality of life . Though the age difference could also have moderated the outcome of their study.

Internal locus of control was also found to be related to quality of life among out-of school youths in Anambra State as shown on Table 2. The implication of this finding was that the youths sense of what

controls their life was an important factor in regulating their every-day functioning and appraisal of their quality of life. This outcome was not surprisngl because it was documetented that internal locus of control can influence how people respond to stressful events in their environment and the motivation to take preventive action. For example, if the youths believe that they were responsible for their quality of life, they will take action to change stressful and unwanted situations around them. This outcome was coroorborated by Pahlevan (2017) who found among 118 Malaysian respondents breast cancer patients. They documented that patients with internal locus of control had the capacity of controling their experiences, lower their anxiety and depression. They concluded that internal locus of control mediated the relationship between an individuals' quality of life. This outcome also supported Rizza, Gison, Bonassi, Dall'Armi, Tonto and Giaquinto (2017) who reported that external locus of control significantly lowers health conditions and quality of life .

This outcome of the third hypothesis shows that the three factors (resilience, internal locus of control and perceived social supports) considered in this study contributed significantily to the prediction of quality of life of out of school youts in Anambra State. This outcome supports the Attribution theory of Weiner (1986) who argue that human behaviour is determined by a combination of internal forces (abilities or efforts) and external forces(task difficulty or luck). Similarly, Lewin (1936) and Tolman(1932), using the cognitive opined that it is how the individual perceive the adversity rather than the adversity itself that will determine whether or not the individual will have a good quality of life. The second hypothesis reveal that the three factors (resilience, internal locus of control, and perceived social supports) when combined accounted for 50.2% of the variance in predicting quality of life of among youths in Anambra State. The implication of the finding is that the three independent variables alone cannot explain the quality of life of out –of school youths in Anambra State since it accounted for only 50.2 %. There was likelihood therefore, that some variables that were not considered in this study could account for youths quality of life. This outcome supports previous studies who reported that other factors such as wealth (Lodhi, Rabbani & Khan, 2021), sense of community, (Stevens, Guerrero. Green, & Jason, 2018) and religious beliefs (Counted, Possamai & Meade, 2018) were positively associated with quality of life. It also gave credence to Lodhi, et al., (2021) Integrated theory which suggest that quality of life composed of eight dimensions, namley; education, environment, economic and physical safety, material living condition governance and political voice, social interaction and personal activities.

Further, the results show that out of the three factors considered in this study resilience was most potent in predicting quality of life among out -of -school youths in Anambra State, Nigeria. This finding corroborates the studies of (Stainton, et. al, 2019; Laird, et al.,2019). However, this outcome was very surprising. One would expect that perceived social support would have stronger contribution to quality of life due to documented evidence that social support is a key component which assist people to build up , have strength to carry on and thrive during times of stress (Lodhi, et al., 2021). There is need to generalize the outcome of this study with caution. This is because of some methodological issues that need mentioning. One such limitation was the small sample size randomly sampled from Anambra State out of 36 States in Nigeria. It is recommended that similair rsearchers should target other States in Nigeria using larger sample size possibly drawn from the six geographical zones in Nigeria. Further, cross-sectional design used for this study did not enable the Researcher to have insights into other issues which may have impacted on the partcipants quality of life. It is recommended that future studies should use traangulation method (combination of quantitative and qualitative methods). These issues did not however, invalidate outcomes of the study because the Researcher adhered strictly to methods of conducting a survey study.

CONCLUSION

The finding of study suggests that resilience, internal locus of control and perecived social supports were positively related to quality of life among out of school youths in Anambra State, Nigeria. This finding has practical implication for health workers, counselling pscyhologists, and social workers when designing intervention to enahnce quality of life among this cohort. In addition, it shows that though the three independent variables considered in this study when combined can contribute to the prediction of quality of life among youths, however, there is possibility that other factors not considered in this study could also account for quality of life among out-of school youths in Anambra State. The implication of this finding is that stakeholders should look beyond the three variables considered in this study when designing intervention to improve youths quality of life.

RECOMMENDATIONS

The following recommendations are suggested on the basis of the study outcomes:

Counselling Psychologists should institute resilience-focused therapy to build the practical skills of out of school youths to become capable of handling their everyday challenges.

Since in this study social supports was shown to be a protective factor for youths quality of life, it is suggested that counselling psychologists, social workers and other workers in helping profession should synergize to mobilise social supports for the out-of-school youths in Anambra State.

Counselling Psychologists should use cognitive therapies to restructure and replace the youth's negative thoughts to enable them to stop blaming external factors for whatever happens in their lives including successes and failures.

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CONFLICT OF INTERESTS

The author hereby declares no conflict of interests

REFERENCES

Baptista, F. M., Rodrigues, A. M., Gregório, M. J., de Sousa, R., Cruz, E., & Canhão, H. (2018). Functional Status and Quality of Life Determinants of a Group of Elderly People With Food Insecurity. Frontiers in Nutrition, 5, 99.https://doi.org/10.3389/fnut.2018.00099

Behzadifar, M, Abdi, S, Malekzadeh, R, Arab Salmani, M. & Ghoreishinia, G, et al. (2016). Prevalence of food insecurity in Iran: a systematic review and meta-analysis. Archives of Iranian Med. 19(4), 288–294. [PubMed] [Google Scholar]

Deniz, Ö, S. Melek, O., & Yanardağ, Z. (2019). Perceived social support, quality of life and satisfaction with life in elderly people, Educational Gerontology, 45(1), 69-77, DOI: 10. 1080/03601277.2019.1585065Edwards, T. C. & Topo ski, T. D. (2002). Adolescent quality of life, part II: initial validation of a new instrument. Journal of adolescence, 25(3), 287–300.https://doi.org/ 10.1006/ jado. 2002. 0471

Gil-Lacruz, M., Gil-Lacruz, A.I. & Gracia-Pérez, M. L. (2020). Health-related quality of life in young people: the importance of education. Health Qual Life Outcomes 18, 187 https://doi.org/10.1186/s12955-020-01446-5

Greene, R. R., Galambos, C., & Lee, Y. (2004). Resilience theory: Theoretical and professional conceptualizations. Journal of Human Behavior in the Social Environment, 8(4), 75-91.

Ibeanu, O, Iwuamadi, O, & Nkwachukwu, C. (2016). Biafra Separatism: Causes, Consequences and Remedies" Institute for Innovations in Development: 1–71 – via Research Gate

Kassianos, A. P., Symeou, M., &Ioannou, M. (2016). The health locus of control concept: Factorial structure, psychometric properties and form equivalence of the Multidimensional Health Locus of Control scales. Health Psychology Open. https://doi.org/ B10.1177/ 2055102916676211

Laird, K. T., Lavretsky, H., Paholpak, P., Vlasova, R. M., Roman, M., St Cyr, N., & Siddarth, P. (2019). Clinical correlates of resilience factors in geriatric depression. International psychogeriatrics, 31(2), 193–202.https:// doi.org/ 10.1017/S1041610217002873

Lewin, K. (1936). Principles of topological psychology. New York: McGraw-Hill; 1936. [Google Scholar]

Lodhi, F.S., Rabbani, U., & Khan, A.A. (2021). Factors associated with quality of life among joint and nuclear families: a population-based study. BMC Public Health 21, 234 Accessed on September, 2021 from https://doi.org/ 10.1186/s12889-021-10265-2

McAnena, C., Craissati, J., & Southgate, K. (2016).Exploring the role of locus of control in sex offender treatment. J. Sex. Aggress. 22, 95–106. doi: 10.1080/13552600.2015.1023374

Mester L. Bugnar, N., & Andreea, F. (2011). The Impact of the Crisis on the Quality Of Life and Solutions to reduce the crisis effects. Case study. Romania, Annals of Faculty of Economics, University of Oradea. 1, 129-133.

Moghadam, K., Mansour-Ghanaei, R, Esmaeilpour-Bandboni, M, & Atrkar-Roshan, Z. (2020). Investigating the relationship between social support and quality of life in the elderly. J Edu Health Promotion 9:215. Assessed on September, 2021 from: https: //www.jehp. net/ text.asp? 2020/9/1/215/293928

Pahlevan, S. S. (2017). Locus of control, quality of life, anxiety, and depression among Malaysian breast cancer patients: The mediating role of uncertainty. European journal of oncology nursing: the official journal of European Oncology Nursing Society, 27, 28–35. https:// doi.org/10.1016/j.ejon.2017.01.005

Pardeller, S., Kemmler, G., Hoertnagl, C. M., & Hofer, A. (2020). Associations between resilience and quality of life in patients experiencing a depressive episode. Psychiatry research, *292*, 113353.https:/ /doi.org/ 10.1016/ j.psychres. 2020.113353

Reknes, I., Visockaite, G., Liefooghe, A., Lovakov, A., & Einarsen, S. V. (2019). Locus of control moderates the relationship between exposure to bullying behaviors and psychologicalstrain. FrontiersinPsychology,10, Article1323https://doi.org/10.3389/ fpsyg.2019.01323

Rizza, F., Gison, A., Bonassi, S., Dall'Armi, V., Tonto, F., & Giaquinto, S. (2017).'Locus of control', health-related quality of life, emotional distress and disability in Parkinson's disease.Journal of Health Psychology, 22(7), 844–852. https:// doi.org/ 10.1177/ 135910531 5616471

Rotter, J. B.(1954). Social learning and clinical psychology. Prentice-Hall, Inc. https:// doi.org/10.1037/10788-000.

Smith, B. W., Dalen, J., Wiggins, K., Tooley, E., Christopher, P., & Bernard, J. (2008). The Brief Resilience Scale: Assessing the ability to bounce back. International Journal of Behavioral Medicine, 15(3), 194–200. https:// doi.org/ 10.1080/ 10705500802222972

Stainton, A., Chisholm, K., Kaiser, N., Rosen, M., Upthegrove, R., Ruhrmann, S., & Wood, S. J. (2019).Resilience as a multimodal dynamic process. Early intervention in psychiatry, 13(4), 725–732.https://doi.org/10.1111/eip.12726.

Suárez - Álvarez, J., Pedrosa, I., García - Cueto, E, & Muñiz, J. (2016). Locus of Control revisited: development of a new bi - dimensional measure. Anales de Psicología, 32(2), 578-586 Assessed on Jjune, 2021 from en: https:// www.redalyc.org/articulo.oa?id=16745250030.

Temprado, M. D., Martínez, P., Ballester Arnal, R., & Collado-Boira, E. J. (2020). The relationship between resilience and quality of life in patients with a drainage enterostomy. Journal of health psychology, 25(10-11), 1483–1497.https://doi.org/ 10.1177/ 1359105318761555.

The World Health Organization (2012).Quality of Life (WHOQOL). Retrieved on October, 2021 from https://www.who.int/tools/whoqol

Tolman, E. C. (1932). Purposive behavior in animals and men. New York: Appleton Century; [Google Scholar]

United Nations International Children's Emergency Fund (2019). Child rights and why they matter. Retrieved on September, 2021 from:https:// www.unicef.org/child-rights-convention/child-rights-why-they-matter.

Vayachuta, P., Ratana-Ubol, A., & Soopanyo, W. (2016). The study of 'out-of-school' children and youth situations for developing a lifelong education model for 'out-of-school' children and youth. SHS Web of Conferences. 26. 01015. 10.1051/shsconf/20162601015.

Weiner, B. (1986). Attribution, emotion, and action. In R. M. Sorrentino & E. T. Higgins (Eds.), Handbook of motivation and cognition. Foundations of social behavior (pp.281312). Guilford Press.

Zdun-Ryzewska, A. Basiński, K, Majkowicz, M., Podolska, M., Landowski, J. & Walden-Gałuszko, K..(2018). Association between social support and quality of life in patients with affective disorders. The European Journal of Psychiatry.32. 10.1016/j.ejps y.2018.05.002.

Zimet, G. D., Dahlem, N. W., Zimet, S. G., & Farley, G. K. (1988). The Multidimensional Scale of Perceived Social Support. Journal of Personality Assessment, 52(1), 30–41. https://doi.org/10.1207/s15327752jpa5201_2

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Disinfection of Drinking Water and Trihalomethanes

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ABSTRACT: Best known by-products of chlorination of drinking water are trihalomethanes (THMs) which can have negative effects on human health. The research goals in this paper were to emphasise the importance of THMs as by-products of disinfecting drinking water, to show the practice of controlling the THMs in drinking water on the example of three water supply systems in the Republic of Srpska and to propose measures for reducing formation of THMs in drinking water. The results have shown that values of THMs in drinking water in these three water supply systems were within the reference values, but the level of the proscribed control is significantly below the minimal requirements.

Keywords: disinfection of drinking water, trihalometanes.

INTRODUCTION

Disinfection is definitely the most important step in preparing water for public supply, but besides being strong biocides, disinfectants are also reacting with other components in water thus creating new compounds with potentially harmful long-term health side-effects. Therefore, a general assessment of the impact of disinfection on public health must take into account not only the microbiological quality of the treated water, but also the toxicity of disinfectants and their reaction products, or as they are commonly called, water disinfection by-products (Dalmacija at al., 2006.).

The type of disinfection by-products depends primarily on the applied disinfectant, and then on water quality parameters (type and concentration of natural organic matter, presence or absence of bromide and iodide ions, pH, temperature, organic nitrogen concentration, etc.), as well as on operating conditions (disinfectant doses and contact times) applied in order to simultaneously achieve effective disinfection and provide requirements for achieving residual disinfectant concentrations (Tričković at al., 2005.).

In our country, but also worldwide, the most commonly used disinfectant for drinking water are chlorine and chlorine preparations. The advantage of using chlorine for water disinfection is that it has rapid effect on microorganisms, it has residual effect which ensures safety of subsequent water pollution, and is an affordable method.

The best-known by-products of water chlorination are certainly trihalomethanes (THMs), out of which the following are important as water contaminants: bromoform, dibromochloromethane, bromodichloromethane and chloroform. Reducing the concentration of these four most commonly reported THMs should decrease the concentration of other uncharacterized chlorination by-products (Ivančev-Tumbas, 1998.). Chloroform is usually the most abundant in drinking water. Its effects on health are also most researched.

As early as the 1970s, research began on the possible effects of by-products resulting from the disinfection of drinking water on human health (Bellar at al., 1974; Hrudey, 2009; Rook, 1974.). In 1976, the National Cancer Institute published the carcinogenic effect of chloroform using rodent research (Boorman

at al., 1999; Singer, 1993.). Following these results, in 1991 the International Agency for Research on Cancer of the World Health Organization classified chloroform and other widespread by-products of disinfecting drinking water as possible carcinogens (ARC, 1999). Looking at THMs as a whole, numerous studies examining the effect of THMs on human health have found that eating and drinking, transdermally or by inhalation can lead to a number of health issues, so THMs were classified as carcinogenic and mutagenic compounds (WHO; Lee at al., 2004; Min at al., 2016; Hang at al., 2016.).

Various meta-analyses and pooled studies in Europe and North America have provided consistent evidence that long-term exposure to t THMs is associated with an increased risk of bladder cancer and colorectal cancer (Kargalioglu at al., 2002; Gruau, 2004; Monarca at al., 2004; Costet at al., 2011; King at al 2006); Villanueva at al., 2003.). One recent multicentre study found no clear evidence of an association between total lifetime THMs exposure and colon cancer (Villanueva at al., 2017). If the activity of individual fractions was observed, then this study revealed a protective effect of chloroform, while a positive association with brominated trihalomethanes was observed in men at the tail end of the exposure distribution, with the key conclusion being that these results require confirmation. Other studies have also reported an association between these compounds and adverse reproductive effects such as congenital anomalies, cancer, and fetal development during pregnancy (Nieuwenhuijsen at al., 2009 A; Nieuwenhuijsen Nieuwenhuijsen at al., 2009 B.).

In studies of the human population using chlorinated drinking water in which chloroform is predominantly THMs, small increases in the incidence of rectal, colon, and bladder cancers have been consistently observed, and the strongest evidence was given for bladder cancer (Kargalioglu at al., 2002; Gruau, 2004; Monarca at al., 2004.). However, since other possible carcinogens have been found in this water, it is impossible to identify chloroform as the only carcinogen. Therefore, the U.S. Environmental Protection Agency classified chloroform as group B2 or "probable carcinogen for humans," based on sufficient animal evidence and inadequate human evidence of carcinogenicity. Evidence from animal studies now strongly suggests that exposure to chloroform causes cancer only after it produces permanent cellular toxicity. Because a certain threshold level of exposure is required to induce cell toxicity, the occurrence of cancer due to exposure to chloroform is only possible if this threshold is exceeded.

In many countries, including the Republic of Srpska, the obligation to control trihalomethanes in drinking water is legally proscribed.

This study aimed to indicate the importance of determining THMs as a by-product of disinfecting drinking, to show the practice of controlling the THMs in drinking water on the example of three water supply systems in the Republic of Srpska and to propose measures for reducing formation of THMs in drinking water.

MATERIALS AND METHODS

The research was conducted as a retrospective study that included the results of analysis of drinking water samples from the central water supply systems of Doboj, Derventa and Teslić on total THMs and its main fractions, in the period 2017 - 2019. The Central Protocol of the Laboratory of the Public Health Institute of the Republic of Srpska - Banja Luka was used as data source.

Water sampling was performed by experts from the Institute of Public Health of the Republic of Srpska in accordance with Water quality – Sampling – Part 3 : Preservationand handling of water samples(BAS EN ISO 5667-3.2018) and Water quality – Sampling – Part 5: Guidance on sampling of drinking water from tretment works and piped distribution systems (ISO 5667 -5). The analyzes were performed in the Laboratory of Sanitary Chemistry of the Institute of Public Health of the Republic of Srpska, by the method of gas chromatography with the use of ECD detectors.

Determination of the correctness of water samples was performed according to the Rulebook on the health safety of water intended for human consumption [23]. The results of the analyses are presented in the form of tables. Descriptive statistics methods were used in data processing.

RESULTS

In the observed period 2017-2019 it has been found that in the city water supply system in Doboj, the analysis for the presence of total THMs was performed within the regular basic water inspections, performing sampling once per month (Table 1)

Table 1. Analyses results of water samples from the central water supply system in Doboj for total trihalomethanes in the period 2017 – 2019 (µg/L)

Month	2017	2018	2019	Reference value (µg/L)
January	5,3	<0,5	<0,5	≤100
February	2,4	<0,5	4,5	≤100
March	2,3	<0,5	11,2	≤100
April	3,5	1,8	23,0	≤100
May	2,2		7,6	≤100
June	3,0	0,8	4,4	≤100
July	5,3	<0,5	18,9	≤100
August	3,0	6,0	4,1	≤100
September	<0,5	0,5	8,6	≤100
October	2,6	1,0	14,4	≤100
November	2,9	3,6	13,2	≤100
December	1,7	12,6	4,8	≤100

All values of total THMs were within legally permitted concentrations (≤100 µg/L) (Službenik glasnik Republike Srpske 88/17). The highest concentration of total THMs was recorded in April 2019 being up to 23.0 µ g / L, which is four times less than the maximum allowed concentration.

Although these are acceptable concentrations, there is a noticeable increase in the concentrations of total THMs in 2019 compared to the previous two years.

From June 2017, the analysis of drinking water for certain fractions of THMs was started: chloroform, bromodichloromethane, dibromochloromethane, bromoform. Since chloroform is of the greatest importance, these are the results shown in Table 2. As in the case of total THMs, all chloroform concentrations were within the permitted values. The highest concentrations of chloroform were recorded in April and July 2019, and in December 2018.

Table 2. Analyses results of water samples from the central water supply system in Doboj for the presence of chloroform in the period 2017 – 2019 (µg/L)

Month	2017	2018	2019	Reference value (µg/L)
January	-	<0,5	<0,5	≤100
February	-	<0,5	1,2	≤100
March	-	<0,5	9,2	≤100

April	-	0,5	19,8	≤100
May	-	-	4,0	≤100
June	-	<0,5	2,2	≤100
July	1,2	<0,5	13,0	≤100
August	<0,5	<0,5	1,8	≤100
September	<0,5	0,5	3,6	≤100
October	<0,5	<0,5	9,5	≤100
November	<0,5	0,8	9,5	≤100
December	-	11,7	1,2	≤100

The water analysis of the water supply system in Teslić was performed as part of the periodic water inspection in September 2017 and November 2018, and the obtained results are shown in Table 3.

Table 3. Analyses results of water samples from the central water supply system in Teslić for the presence of total trihalomethanes in 2017 and 2018 (µg/L)

Parameter	2017	2018	Reference value (µg/L)
Trihalomethanes - total	22,4	15,0	≤100
Chloroform	21,4	14,0	≤100
Bromodichloromethane	1,0	1	≤100
Dibromochloromethane	<0,5	<0,5	≤100
Bromoform	<0,5	<0,5	≤100

Concentrations of total THMs and individual fractions were within the prescribed limits.

Table 4. Analyses results of water samples from the central water supply system in Derventa for the presence of total trihalomethanes in 2017(µg/L)

Parameter	2017	Reference value (µg/L)
Trihalomethanes - total	0,9	≤100
Chloroform	<0,5	≤100
Bromodichloromethane	<0,5	≤100
Dibromochloromethane	0,9	≤100
Bromoform	<0,5	≤100

The control of the presence of THMs in the water from the Central Water Supply of the Municipality of Derventa was performed once a year, as part of the periodic inspection, only in 2017. The obtained results of total and individual THMs in 2017 are shown in Table 4.

DISCUSSION

In the Republic of Srpska, according to the Rulebook on the health safety of water intended for human consumption, total THMs should be determined as an integral part of the basic inspection of drinking water (Službenik glasnik Republike Srpske 88/17).

In Teslić and Derventa, the control was performed only in 2017 and 2018, i.e. 2017, namely the analysis of one sample within the periodic inspection of water. So it can be said that the minimal control that has just been started, has been stopped.

Determination of THMs in drinking water from the central water supply system in Doboj was performed in the observed period of three years doing one analysis per month. However, if we take into account that the basic water inspection in Doboj is performed three times a month, when each time sampling and analysis of water is performed with seven or eight control points, then the stated number of analyzes for THMs is far below the prescribed norms.

The maximum permissible concentration of total THMs in drinking water in the Republic of Srpska is 100 μg / l, 23 which is in accordance with the recommendations of the World Health Organization, i.e. the European Union regulations on maximum permissible pollution of drinking water with total THMs which is the sum of chloroform, bromodichloromethane, dibromochloromethane and bromoform (European Commission, 1998.).

The results of analyses of drinking water from the central water supply system in Doboj for THMs showed that all values of THMs in the observed period were within the allowed limits. The highest values of total THMs s were recorded in April (23.0 μg / l) and July (18.9 μg / l) 2019, which was again four to five times lower than the maximum permitted concentrations for total THMs. The highest measured concentrations of THMs in water samples were recorded mostly in the summer months, while the lowest values were in the first months of the observed years. Such variation in THMs concentrations can be related, in particular, to a change in the amount of organic matter present in the water. The upward trend during the summer months compared to the downward trend in the colder period of the year is characteristic of temperate climates (Gray, 2008; Brown at al., 2011.). Temperature and seasonal variation of natural organic matter also affect the formation of THMs, while during summer months, due to rinsing of organic matter, an increase in the formation of THMs was observed compared to the winter period. If we analyse the values of total THMs by years, then it is clear that the highest concentrations were recorded in 2019.

As already presented in the results, from June 2017 the concentration values for individual THMs (chloroform, bromodichloromethane, dibromochloromethane and bromoform) were also examined. Chloroform concentrations have shown that the values of total THMs largely "depend" on the values of chloroform. This means that the values of chloroform, as with total THMs, are highest in the summer months and lowest during low temperature periods.

Bromodichloromethane, dibromochloromethane and bromoform are three compounds with bromine that are also formed as by-products of water disinfection, due to the presence of organic matter, but are primarily formed with increased bromide content, which is not present in large quantities in fresh natural waters (Dogančić, at al.) Thus, in the presence of bromide, brominated trihalomethanes are formed, while the concentration of chloroform decreases proportionally.

Given the extremely low, extremely negligible number of analyses of drinking water from the water supply system in Derventa and Teslić for trihalomethanes, we cannot give any comments on those results.

The problem of THMs has so far been insufficiently dealt with by the profession and science in the Republic of Srpska. Sufficient proof for this claim is the fact that even in the annual reports of drinking water analyses of the Public Health Institute of the Republic of Srpska (authorized by law for public control of trihalomethanes in drinking water) the analysis of trihalomethane has not been given a single word.

At the same time, from the Report on the health safety of water for human consumption in the Republic of Croatia for 2018 (Hrvatski zavod za javno zdravstvo), published by the Croatian Institute of Public Health, we find out that 584 analyses for THMs were performed in the observed year, and that only in the case of one analysis (0.2%) the value of THMs exceeded the legally allowed maximum value of 100 μg / l.

Epidemiological studies have long been conducted in various European countries indicating great variability in levels within (Villanueva at al., 2017.) and between (Jeong at al., 2012.) the countries. European research project Health impacts of long-term exposure to disinfection by-products in drinking water (HIWATE), reported that in 2010 levels of THMs in drinking water in seven cities in five European countries ranged from below the detection limit (Modena, Italy) to above the currently regulated maximum limit (Barcelona, Spain) (Jeong at al., 2012.).

The situation in the countries of the European Union, and the importance of determining trihalomethanes and interpretation of the obtained findings, and if necessary taking certain measures, were best shown by the results of the European project EXPOsOMICS whose goal was to calculate the estimate of THMs levels in drinking water all over the Europe and assess the associated burden of bladder cancer using different exposure scenarios. This study included 28 countries of the European Union. The findings showed that current average levels of THMs in drinking water in all EU countries were below European regulatory limits, although maximum levels showed exceedances in nine countries. The key conclusion of this study was that assuming a cause-and-effect relationship, current exposure to THMs in the European Union could lead to a significant number of bladder cancer cases that could be avoided by optimizing water treatment, disinfection and distribution, among other measures, without compromising microbiological quality of drinking water (Evlampidou at al). [30]

The amount of THMs that will be formed depends on the amount of precursors, the amount of chlorine used for disinfection and the length of contact between water and chlorine (longer contact means higher production of THMs) (Matošić at al., 2007.). There are several options for controlling disinfection and disinfection by-products: moving the disinfection point, removing by-products when they have already been created, removing precursors or natural organic matter before reacting with disinfectants, or using disinfectants that minimize by-product formation.

The cheapest approach to control is to move the disinfection point or use an alternative disinfectant. The least desirable approach is to remove disinfectant by-products when they have already been created.

The best approach to control is to remove precursors before they react with the disinfectant. Currently, a large number of different techniques are used to reduce the content of by-products precursors in water, of which the most commonly used are conventional physicochemical methods, such as coagulation processes with iron and aluminium salts, filtration on single-medium and dual-media filters, and GAU filtration (Yan at al., 2007).

CONCLUSION

Trihalomethanes (chloroform, bromodichloromethane, dibromochloromethane, bromoform) are the most important by-products of water disinfection by chlorine and chlorine compounds.

Previous studies have shown that THMs are probable or possible carcinogens, that they can have a mutagenic effect, and that they affect the occurrence of respiratory diseases.

Due to risk to human health, determination of THMs in drinking water, which is still predominantly being chlorine disinfected, is done.

In the period 2017-2019, the analysis of drinking water for total THMs, as well as for certain compounds (chloroform, bromodichloromethane, dibromochloromethane, bromoform) in drinking water from Doboj water supply system was performed once a month.

In the period 2017-2019, in Teslić and Derventa, the control was performed once a year, as part of the periodic inspection of drinking water, but not on a regular basis (analyzes in Teslić were done in 2017 and 2018, in Derventa only in 2017).

Water control level in Doboj water supply system, and especially in the water supply systems in Derventa and Teslić, is below the proscribed level.

The results of the analysis for THMs (chloroform, bromodichloromethane, dibromochloromethane, bromoform) in water samples from Doboj water supply system showed that the obtained concentrations THMs (individually or in total) were not above the permitted value (MDK 100 μg / L).

The highest measured concentrations of trihalomethane were recorded mostly during summer months, while the lowest values were in the first months of the observed years, which is most likely related to the change in the amount of organic matter present in the water, which is characteristic of temperate regions.

Although still significantly below the maximum allowable concentrations for total THMs and compounds, there is an evident increase in their concentrations in 2019 compared to the previous two years.

Measures to reduce the formation of THMs in drinking water are the removal of precursors or natural organic matter before they react with disinfectants, the use of alternative disinfectants that minimize the formation of by-products, and the least desirable approach is the removal of disinfectant by-products when already created.

REFERENCES:

ARC (International Agency for Research on Cancer). 1991. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans: Chlorinated Drinking Water; Chlorination By-Products; Some Other Halogenated Compounds; Cobalt and Cobalt Compounds. vol. 52. Available at https://monographs.iarc.fr/wp-content/uploads/ Accessed 10.06.21. .

Bellar, TA., Lichtenberg, JJ., Kroner, RC. (1974). The occurrence of organohalides in chlorinated drinking waters. J AWWA, 66, 703–706.

Boorman, G.A, at al. (1999). Drinkingwater disinfection byproducs: review and approach to toxicity evaluation. Environ Health Persp, 107, 207–217.

Brown, D., Bridgeman, J., West, JR. (2011). Predicting chlorine decay and THM formation in water supply systems, Reviews in Environmental Science and Bio/Technology, 10, 79–99.

Costet, N., Villanueva, C.M., Jaakkola, JJK., Kogevinas, M., Cantor ,K.P., King, W.D., et al. (2011). Water disinfection by-products and bladder cancer: is there a European specificity? A pooled and meta-analysis of European case-control studies. Occup Environ Med, 68(5), 379–385.

Dalmacija, B., Agbaba, J. (2006). Kontrola kvaliteta vode za piće. Univerzitet u Novom sadu, Prirodnomatematički fakultet. Novi Sad.

Dogančić, D., Siročić, AP., Sakač, N., Romić, T., Tomie, I. Određivanje trihalometana u vodi. Hrvatske vode.

EC 1998 EC (European Commission). Council directive of 3 November 1998 on the quality of water intended for human consumption. European Council Directive 98/83/EC. Off J Eur Communities, 1998: L330:23.

Evlampidou, I., at all. Trihalomethanes in Drinking Water and Bladder Cancer Burden in the European Union. EHP Preuzeto sa: https://ehp.niehs.nih.gov/doi/full/ Accessed 15.05.21.

Gray, N. F. (2008). Drinking water quality: problems and solutions, Cambridge, UK: Cambridge University Press.

Gruau, G. (2004). Les sous-produits chlore´s dans les eaux destine ´es a`l'alimentation humaine. Rapport d'e´tude remis a` la DRASS Bretagne et a` la re´gion Bretagne. 30 september 2004. CAREN, UMR 6118 Ge´osciences Rennes, Rennes/France human cells. Mutat Res, 513, 151–157.

Hang, C., Zhang, B., Gong, T., Xian, Q. (2016) Occurrence and health risk assessment of halogenated disinfection byproducts in indoor swimming pool water, Science of The Total Environment, 543, 425-431.

Hrudey, SE. (2009). Chlorination disinfection by-products, public health risk tradeoffs and me. Water Res, 43(8), 2057–2092.

Hrvatski zavod za javno zdravstvo. Izvještaj o zdravstvenoj ispravnosti vode za ljudsku potrošnju u Republici Hrvatskoj za 2018. godinu. Preuzeto sa: https://www.hzjz.hr/sluzba-zdravstvena-ekologija/izvjestaj-o-zdravstvenoj-ispravnosti-vode-za-ljudsku-potrosnju-u-republici-hrvatskoj-za-2018-godinu/ Accessed 08.06.2021.

Ivančev-Tumbas, I. (1998). Nusproizvodi dezinfekcije vode za piće. U: Dalmacija B, Kvalitet vode za piće – problemi i rešenja (str. 115-138). Instutut za hemiju. Novi Sad.

Jeong, CH., Wagner, ED., Siebert, VR., Anduri, S., Richardson, SD., Daiber, EJ, et al. (2012). Occurrence and toxicity of disinfection byproducts in European drinking waters in relation with the HIWATE epidemiology study. Environ Sci Technol, 46 (21), 12120–12128.

Kargalioglu, Y., Mcmillan, B.J., Minear, R.A., Plewa, M.J. (2002). Analysis of the cytotoxicity and mutagenicity of drinking water disinfection by-products in Salmonella typhimurium. Teratog Carcinog Mutagen, 22, 113–128.

King, WD., Marrett, LD. (1996). Case-control study of bladder cancer and chlorination by-products in treated water (Ontario, Canada). Cancer Causes Control, 7(6):, 96–604.

Lee, S.C., Guo, H., Lam, S.M., Lau, S.J. (2004). Multipathway risk assessment on disinfection by-products of drinking water in Hong Kong. Environmental Research, 1, 47-56.

Matošić, M., Mijatović, I. (2007). Tehnologija vode. Prehrambeno – biotehnološki fakultet, Sveučilište u Zagrebu.

Min, J.Y., Min, K.B. (2016). Blood trihalomethane levels and the risk of total cancer mortality in US adults. Environmental Pollution, 212, 90-96.

Monarca, S., Zani, C., Richardson, S.D., ADJr T., Moretti, M., Feretti, D.,Villarini, M. (2004). A new approach to evaluating the toxicity and genotoxicity of disinfected drinking water. Water Res, 38, 3809–3819.

Nieuwenhuijsen, MJ., Martinez, D., Grellier, J., Bennett, J., Best, N. (2009 A). Review chlorination disinfection by-products in drinking water and congenital anomalies : review and meta-analyses. Environ Health Perspect, 117(10), 1486–1493.

Nieuwenhuijsen, M., Grellier, J., Smith, R., Iszatt, N., Bennett, J., Best, N., et al. (2009 B). The epidemiology and possible mechanisms of disinfection by-products in drinking water. Phil Trans R Soc A, 367, 4043–4076.

Rook, JJ. (1974). Formation of haloforms during chlorination of natural waters. Water Treat Exam, 23, 234–243.

Singer, P.C. (1993). Formation and characterization of disinfection by-products. In: Craun GF. Safety of water desinfection: balancing chemical and microbial risks (201–219). ILSI Press, Washington (DC).

Službenik glasnik Republike Srpske 88/17. Pravilnik o zdravstvenoj ispravnosti vode namjenjene za ljudsku potrošnju.

Tričković, J., Agbaba, J. (2005). Dezinfekcini nusproizvodi U: Dalamacija, B, Dezinfekcija vode (str. 252-275). Prirodno – matematički fakultet, departman za hemiju. Novi Sad.

Villanueva, CM., Fernández, F., Malats, N., Grimalt, JO., Kogevinas, M. (2003). Meta-analysis of studies on individual consumption of chlorinated drinking water and bladder cancer. J Epidemiol Community Health, 57(3):166–173.

Villanueva, CM., Gracia-Lavedan, E., Bosetti, C., Righi, E., Molina, AJ., Martín, V, et al. (2017). Colorectal cancer and long-term exposure to trihalomethanes in drinking water: a multicenter case–control study in Spain and Italy. Environ Health Perspect, 125(1), 56–65.

WHO. Trihalomethanes in Drinking-water: Background document for development of WHO Guidelines for Drinking-water Quality. Available at https://www.who.int/water_sanitation_health/dwq/chemicals/THM200605. pdf, Accessed 15. 06. 2019.

Yan, MD., Wang, J., Qu, J., Ni, C. (2007). Enhanced coagulation for high alkalinity and micro-polluted water: the third way through coagulant optimization. Water Research, 42 (8-9), 2278-2286.

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Original scientific paper

Effects of Recreational Swimming on Women's Psychosomatic Status

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ABSTRACT: A sedentary lifestyle is characterized by the development of automation and lack of movement that causes various ailments and diseases and thus negatively affects the health of people. This study aimed to determine the effects of recreational swimming on the psychosomatic status of middle-aged women. The subjective assessment of psychosomatic status (SPPSS) scale was used in the study to assess ailments (disorders) of certain body parts and organic systems before and after the experimental treatment. The results of the research show that there were statistically significant changes in all tested variables, and the largest changes were in the variables: back pain ($Z = -5{,}169$, $p < 0.001$) and leg pain ($Z = -4{,}941$, $p < 0.001$), while the smallest changes were in variables indigestion ($Z = -3{,}983$, $p < 0.001$).

Key words: recreational swimming, subjective assessment of psychosomatic status middle-aged women.

INTRODUCTION

Swimming is an excellent natural recreational activity that has multiple beneficial effects on the female body, which is not limited only to physical characteristics but also extends to the mental ones (Lampadari et al., 2016). Swimming is a way of exercising that is very suitable for health promotion and disease prevention and is one of the most popular, most applied, and most recommended forms of physical activity (Tanaka, 2009). A sedentary lifestyle, and with-it sedentary work, are the cause of many ailments and diseases if a person in his spare time does not compensate for the causes by other/opposite activities. Many diseases due to a sedentary lifestyle (obesity, cardiovascular disease, diabetes, stress-causing neuropsychiatric disorders, Penedo, 2005) have been proven and investigated, while, on the other hand, the research of Duggal et al. (2018) confirmed the positive impact of regular physical exercise in the symptoms and diseases of a sedentary lifestyle. From a public health perspective, exercise is one of the most cost-effective means by which health goals can be achieved (Albright et al., 2000). Nowadays, everyone understands that exercise is necessary for physical and mental health. It is difficult to say which model of exercise can be singled out as better because they all have their advantages. However, aerobic exercise is the basis in most models of recreational exercise and as such has a preventive/curative effect on general health. Aerobic exercise can affect weight control and improve cardiovascular function with a low risk of sports injuries (Albright et al., 2000). Middle-aged women who do sedentary office jobs are exposed to risk factors due to insufficient movement. In addition to insufficient movement, the coming period of menopause is also problematic for many women. Hence, by the age of 40, when women's abilities are at their maximum, they have been declining since the age of 40, and this process is accelerated if one does not nurture physical and mental health on a daily basis. That is why the 40s are the turning point when it is not too late that we can help ourselves with a natural way of maintaining psychosomatic health, in which systematic exercise and a balanced diet

predominate. In order to be able to assess their current health in an easier way, subjective assessment by surveys can be used (Andrijašević and Bonacin, 1997). Self-assessment of health is an individual perception and estimation of own health (Lim, E.-J., 2021), and physical activity can influence subjective assessment of health status (Sun et al., 2016) and better quality of life (Brown et al., 2003). Authors Brown et al. (2003) have established that better quality of life, concerning health, had physically active individuals who exercised with higher intensity compare to other tested groups. Subjective health includes absence of disturbing (painful) symptoms, but it has a positive side that is manifested in energetic feeling, vitality and physical health in general (Selgman, 2008). In the present study, we are testing the effects of recreational swimming on subjective assessment of psychosomatic status where ailments/disorders represent indicators of subjective health (Kinnunen et al., 2005). Considering objective picture of sedentary middle-aged women who do office work, a recreational swimming program have been designed that can influence health status and therefore "warn" participants of the experiment about the need to change bad sedentary habits.

MATERIALS AND METHODS

Sample of participants and variables

The experimental study was conducted on a sample of 38 participants (age 35 to 45) who were randomly selected and do sedentary office work. Beforehand, the participants underwent a medical check and only healthy individuals could be included in the research and systematic exercise under the "Recreational Swimming" program. Other criteria for access to the treatment were: that they were female workers and that they were doing office work in a sitting position; that they have no somatic defects or diseases; absence from other organized forms of physical activities other than participating in the "Recreational Swimming" program; regular participation in the exercise program (three times a week) and voluntary acceptance of the exercise program.

Experimental treatment / swimming program

The recreational swimming program lasted 12 weeks. There were three trainings per week, and each one lasted 60 minutes. The training sessions were led by a licensed swimming instructor. The

warm-up and cooling exercises lasted 10 minutes each, and the main exercises lasted 40 minutes. The detailed swimming program is shown in Table 1.

Table 1. Swimming Program

	Exercises	Week	Load	Frequency
Warm up (10 min)	Stretching		RPE 75	
Main exercises (40 min)	1. Crawl – leg stroke	1- 4 week	55-65% HRR (RPE 8-10)	
	2. Breathing while moving			
	3. Floating horizontally			
	4. Movements with swimming board			
	5. Crawl hands	5-8 week	65-75% HRR (RPE 10-12)	
	6. Free style combination			
	7. Leg movements in backstroke			3 / times/week
	8. Crawl swimming			
	9. Arm backstroke	9-12 week	75–85% HRR (RPE 12-14)	
	11. Backstroke swimming			
	12. Breaststroke swimming - legs			
	13. Breaststroke swimming -arms			
	14. Breaststroke swimming			
	15. Breaststroke combination			
Cool down (10 min)	Stretching		RPE 75	

Instrument

A subjective assessment of psychosomatic status was determined by questionnaire SPPSS (Blagajac, 1992; Vučković, 2003). The SPPSS questionnaire defines ailments/disorders where examinee evaluates existence and severity of certain ailments on a scale from 1 to 9 (1 – do not feel it to 9 – unbearable). Defined pains were divided by body parts into: shoulder and arm pain, back pain, leg pain, fatigue and sensorial discomfort, indigestion, cardiovascular disorders, neuropsychiatric disorders, symptoms of general fatigue.

Statistical data processing

The data collected during the study were analyzed and processed by analytical and statistical program for personal computers IBM SPSS 20.0. For the analysis of data measured by continuous scale at the initial and final measurement, the basic descriptive parameters were calculated, and normality of distribution was checked by Kolmogorov-Smirnov test. The Wilcoxon Signed Rank test was used to test the difference between the initial and final state of the subjective assessment of psychosomatic status. The statistical significance was determined at the level of $p < 0.05$.

RESULTS AND DISCUSSION

The experimental procedure was conducted in order to determine the existence and nature of the effects of recreational swimming in middle-aged women's subjective assessment of psychosomatic status. The results of the experiment revealed that recreational swimming had influence on psychosomatic status of middle-aged women who do office work. Aerobic recreational swimming in deep swimming pool, that lasted three months with three trainings per week, one hour each training, had statistically significant

changes in all tested variables (p = 0.001). Considering the results of the Kolmogorov-Smirnov test, a non-parametric Wilcoxon Signed Rank test was applied with the presented results in further text. In this study, we hypothesized that recreational swimming would be a good way of exercise for positive influence on subjective assessment of psychosomatic health of participants.

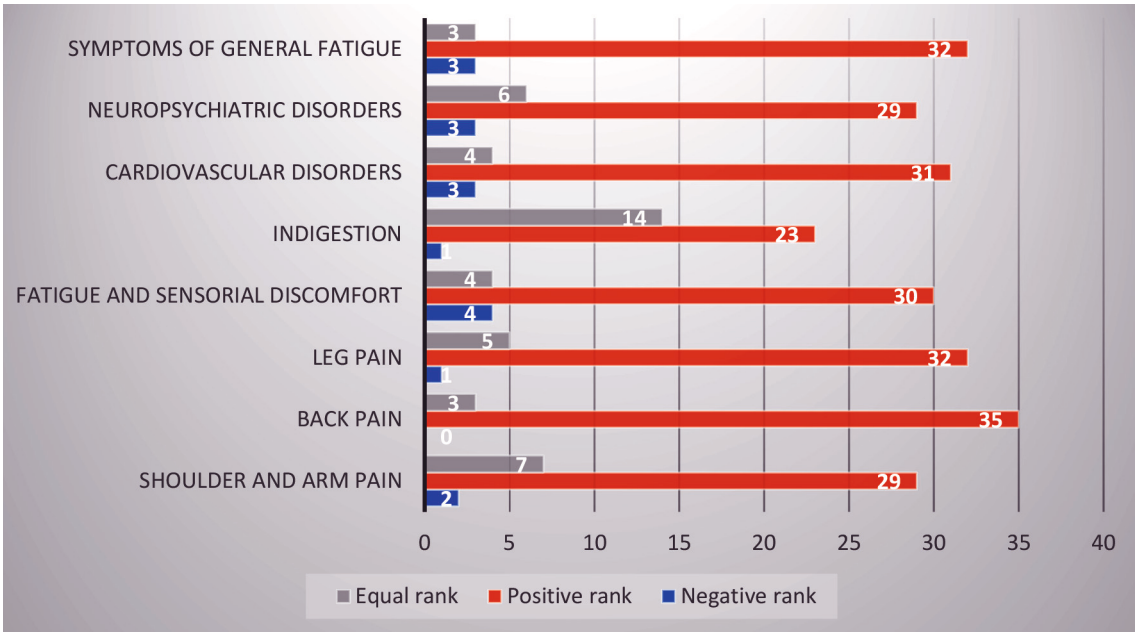

Figure 1. Analysis of differences between initial and final subjective assessment of the psychosomatic status

Observing the obtained results from Figure 1, it can be said that the participants had a visibly positive ranking orientation according to all set estimates after the application of experimental swimming treatment, which led to a statistically significant difference in all applied variables (Table 2).

Table 2. Distribution of variables and the analysis of differences of the subjective assessment of the psychosomatic status of the participants at the initial and final measurement

		Shoulder and arm pain	Back pain	Leg pain	Fatigue and sensorial discomfort	Indigestion	Cardiovascular disorders	Neuropsychiatric disorders	Symptoms of general fatigue
Initial	AS	5.84	5.39	6.44	6.26	3.71	6.65	7.97	7.78
Initial	p	.010	.041	.196	.072	.000	.304	.076	.305
Final	AS	10.84	10.68	11.57	10.50	6.00	12.47	14.76	14.10
Final	p	.529	.875	.480	.273	.142	.473	.523	.605
Z		-4.712	-5.169	-4.941	-4.453	-3.983	-4.646	-4,463	-4.659
p		.000	.000	.000	.000	.000	.000	.000	.000

The analysis of the subjective assessment of the psychosomatic status between the initial and final measurement indicates that there were statistically significant changes in all tested variables (Table 2.). The largest differences appeared in the variables: back pain (Z = -5.169, p <.001) and leg pain (Z = -4.712, p

<.001), and slightly smaller differences were noted in the variables shoulder and arm pain (Z = - 4.985, p <.001); symptoms of general fatigue (Z = - 4.659, p <.001); symptoms of neuropsychiatric disorder; (Z = -4463, p <.001); cardiovascular disorders (Z = - 4.646, p <.001); fatigue and sensorial discomfort (Z = - 4.453, p <.001). The smallest differences were in the variable indigestion (Z = - 3.983, p <.001). Based on the obtained results, it is notable that there is a statistically significant difference between the initial and the final measurement in all variables and that the differences between the groups of variables are small. It can be concluded that exercising according to the model of recreational swimming can eliminate the problems of psychosomatic status in middle-aged women who perform office sedentary work.

Recreational swimming is a good method for improving/alleviating the difficulties of psychosomatic status and that was confirmed by the final measurement wherein all groups of variables positively oriented ranks prevail. Why was that? Middle-aged women who perform sedentary jobs for several years are chronically burdened with the demands of work and other circumstances. The lack of compensation for chronic fatigue has produced various ailments, which, if left untreated, can progress to another extreme/illness. Water is an environment in which the body feels good, and swimming activity, especially if programmed, can have a positive effect on alleviating the problems and significantly improve functional health compared to a sedentary lifestyle. The result of a significant improvement in health status is certainly organized and systematic exercising in accordance with the recreational swimming program. Besides, the participants included in the experiment had health problems due to the sedentary jobs, therefore it could have been assumed that well-organized training would have a positive impact on improving health status. In this study, the best results were achieved in the group of variables back pain (neck, chest, and low back, Z = -5.169, p <.001). The spine in sedentary jobs is a part of the body that moves very little or almost not at all it is rather static when one is working in a sitting position. This means that the joints of the spine are heavily loaded, and the muscles that hold the spine are passive, which altogether leads to deformation/poor position of the spine that can cause pain in different segments of the spine. How swimming can help in such cases? Firstly, the body in the water is in a horizontal position where all the joints are relaxed, especially in the spine. By swimming movements in the water, we activate almost all the muscles, including the muscles of the spine whose work influences the functionality of the spine. The second-best result in the improvement/elimination of the health problems was the group of variables shoulder and arm pain (shoulders, arms, hands, and fingers, Z = - 4.985, p <.001). The arms are almost under the most load in sedentary jobs with repetitive movements. Certainly, after a long time, chronic fatigue and discomfort start to appear. In this case, the water has a relaxing effect on tired muscles, and with additional/other movements in the water, the arm muscles recover, and their function and motor skills improve. It is no coincidence that the third in a line of the improvement/recovery variables are the symptoms of general fatigue (monotony, drowsiness, insomnia, feeling of weakness, and sluggishness of movement, Z = - 4.659, p <.001). When the locomotor system is in a deficit of movement, it negatively affects the working abilities and the capability of creating the energy required for better health. Swimming can help statically inactive legs and statically loaded arms with various movements in the water. All in order to engage passive muscles and relax overloaded muscles of sedentary jobs, as well as to "awaken" the functions of other organ systems that have a positive effect on the symptoms of general fatigue. Next in the sequential order of recovery/prevention problems are the symptoms of neuropsychiatric disorders (headache, bad mood, indifference-apathy, general discomfort, and irritability Z = - 4.463, p <.001). Prolonged sedentary jobs are in most cases stressful and negatively affect mental mood/stability. Warmer water in the pools and continuous swimming with moderate intensity will enable deeper breathing, better/accelerated circulation with a better oxygen supply needed for the functioning of all organ systems, and the use of muscles that enable all functions to improve neuropsychiatric disorders. Cardiovascular disorders (shortness of breath, quick fatigue, increased sweating,

heart disorders, Z = - 4.646, p <.001) are a direct consequence of the lack of more intense movement. Aerobic training, such as swimming, can influence the improvement of cardiovascular status with swimming-technical elements and methodical procedures. Fatigue and sensorial discomfort (sensitivity to noise, sensitivity to silence and monotonous work, eye fatigue and eye pain, Z = - 4.453, p <.001) are, besides the slower negative impact of a sedentary lifestyle, had statistically significant positive changes at the end of recreational swimming treatment. We believe that it is due to the influence of another/swimming working environment that has a beneficial effect on the overall psychosomatic status. Our results are congruent with some similar studies and examined variables on the impact of recreational swimming and subjective assessment of health status in sedentary women. We deliberate on these works below.

Omar et al. (2021) investigated the impact of regular swimming on the improvement of risk factors for metabolic syndrome. Their hypothesis was that swimming activity has become an important physical activity in the health system that is considered as a practical nonpharmacological approach of assessing the long-term effects of swimming on glycemic and lipidemic parameters, hemodynamic responses, body fat percentage, and index in the treatment of type 2 diabetes (T2DM), hypertension (HTN) and obesity. Forty participants of both genders with T2DM and HTN (age 52.4 ± 5.5 years) participated in the study and were divided into two groups, the swimming group, and the control group. The swimming group exercised for 2 hours, 3 times per week at a pool temperature of 29–33° C for 16 weeks. At the same time, the control group did not participate in the exercises, and they were advised to continue with their everyday lifestyle. The results showed that there were statistically significant differences ($p < 0.05$) in the variables total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL), triglycerides (TG), blood glucose (BG), systolic blood pressure (SBP), diastolic blood pressure (DBP), body mass index (BMI), and percentage of body fat by groups, time, and interaction for the experimental group. The authors suggest that regular swimming for 16 weeks may be a non-pharmacological approach in the treatment of T2DM and HTN.

The effect of regular swimming on body composition, strength, and blood lipids in middle-aged women was investigated by Bo-Ae Lee and Deuk-Ja Oh (2015). A sample of 24 middle-aged women, 12 women in the swimming group and 12 women in the control group were examined. The swimming group performed swimming exercises for 60 minutes three times a week, for a total of 12 weeks, and the control group was not under swimming treatment. The results of the study confirmed the changes in body composition by reduction of body fat percentage in the swimming group. Examination of the differences between the groups revealed statistical significance. The results of strength tests showed that the swimming group had a statistically significant difference in flexibility and cardiovascular endurance. The results of blood lipids showed a decrease in TC and TG and a significant increase in HDL-C, and difference tests confirmed a statistically significant difference in the TC and TG variables. Considering these findings, the authors believe that regular swimming is effective in improving body composition, physical strength, and blood lipids in middle-aged women.

Kurko (2011) investigated the influence of recreational-health swimming on the indicators of subjective and objective health of men aged 20-30. Objective health was estimated based on the pulse and subjective health was checked by questionnaire. The study lasted a year, included 31 participants with training sessions three times a week, and the duration of one training session of 1 hour. The author concluded that recreational-health swimming has a positive effect on the indicators of the objective health of the participants, which manifested in the normalization of the cardiovascular system functioning. Furthermore, swimming had a positive impact on subjective health by reducing the number of complaints of autonomic disorders and psych emotional maladaptation, while self-esteem became more adequate.

Neiva et al. (2018) examined the effects of a 12-week water aerobics program on health indicators and physical fitness in adults and the elderly. Fifteen volunteers (58.80 ± 14.32 years) were part of the experimen-

tal group, and eight volunteers (59.00 ± 12.26 years) were part of the control group. The training sessions of water aerobics lasted 45 minutes twice a week for 12 weeks; exercising was not allowed for the control group in the same period. Evaluations were conducted one week before commencing the program and upon the completion of the training program. Primary outcomes were changes in strength and cardiorespiratory capacity and secondary outcomes included body anthropometry, lipid profile and blood pressure. The adjusted analysis for age and baseline values showed no differences between the exercising group and the control group before and after training. However, there was a moderate tendency to increase the explosive power of the upper limbs ($\bar{e}p2 = 0.17$), decrease body fat ($\bar{e}p2 = 0.17$), decrease systolic blood pressure ($\bar{e}p2 = 0.14$) and triglycerides ($\bar{e}p2 = 0.19$) in exercising group. Changes within the groups indicated that the training program caused an increase in explosive power in the upper limbs (0.26 m, 95% CI, 0.03, 0.49; ES = 0.63). In addition, there was a significant reduction in adipose tissue, 95% CI, -1.74, -0.03; ES = 0.61) and systolic blood pressure (-0.83 mmHg, -1.46, -0.19; ES = 0.71). These results suggest that 12 weeks of water aerobics performed twice a week is beneficial for the explosive power, physical shape, and blood pressure of adults and the elderly, but is insufficient to alter cardiorespiratory capacity and lipid profiles.

Adnan et al. (2019) investigated the assessment of mental health in healthy adult men after a swimming intervention. They tested 28 adults aged 19–33 years that were randomly divided into two groups, a swimming group (n = 14) and a control group (n = 14). They used two sets of questionnaires, the Depression, Anxiety and Stress Scale (DASS) and Mood Profile (POMS), which examined six domains: tension, depression, anger, fatigue, confusion, and strength before and after the intervention. The swimming group underwent an exercise program three times a week for eight weeks, while the control group led an ordinary lifestyle. Initially, significant differences were identified for all parameters measured in DASS and POMS, excluding complete mood disorder and energy domain between the two groups. During the intervention, there were significant differences between the groups in anxiety and stress in DASS, as well as in the energy domain in POMS ($p<0.05$). After eight weeks of exercise, the swimming group showed a significant reduction in all measured outcomes compared to the control group ($p<0.05$). This study shows that eight weeks of swimming can have positive effects on the mental health of adult men during the course. Marinović Glavić et al. (2020) investigated the self-assessment of health and functional abilities of the population older than 75 years regarding gender, marital status, and level of education of the participants. The study included 189 participants, of which 118 were women and 71 were men. For the study, a survey questionnaire composed of selected particles of validated questionnaires was used. Results: Participants were asked questions about their quality of life, whether their health condition limits them in daily activities and how often they are physically active. Based on the results, the connection between gender, marital status, and level of education with the subjective assessment of the health of the elderly population and their functional abilities was confirmed. Conclusion: Functional abilities decrease with age, daily activity restrictions are lower in participants with a higher level of education and gender-wise, women subjectively assess their health worse than men and report greater difficulties in physical functioning.

CONCLUSION

On the basis of conducted study and its aim, it can be concluded that experimental treatment of recreational swimming that lasted three months, three times per week, an hour each session, had positive influence on the psychosomatic status of middle-aged women. The efficacy of the experimental treatment proved to be statistically significant for all tested variables. Among the eight groups of variables, we emphasize variable groups back pain and leg pain as groups with larger impact of recreational swimming, and somewhat weaker results were confirmed in group indigestion. Furthermore, it is noticed that "swimming

pool water" with an experienced/licensed instructor good motive for active style and an escape from the sedentary life among middle-aged women who do office work. Authors conclude that exercising in accordance to the recreational swimming model in deep water can eliminate problems of psychosomatic status of middle-aged women who do office work.

Conflict of interests

The authors declare that there is no conflict of interest.

REFERENCES

Adnan M. W., Sedek R., Mutalib S. A, Kasim Z., Kashim M. I. A. M., Idris F. and Yusof A. Effects of swimming towards mental health in collegiate male adults. Malays. Appl. Biol, 2019; 48(2):141–148.

Albright, C.L.; Cohen, S.; Gibbons, L.; Miller, S.; Marcus, B.; Sallis, J.; Imai, K.; Jernick, J.; Simons-Morton, D.G. Incorporating Physical Activity Advice into Primary care: Physician-delivered Advice within the Activity Counseling Trial. Am. J. Prev. Med. 2000, 18, 225–234. [CrossRef]

Andrijašević M., Bonacin D. Subjektivne tegobe odraslih žena u odnosu na kronološku dob i bavljenje kineziološkim aktivnostima. Kinesiology: international journal of fundamental and applied kinesiology, 29 (1997), 1; 71-74.

Brown, D. W., Balluz, L. S., Heath, G. W., Moriarty, D. G., Ford, E.S., Giles, W. H. & Mokdad, A. H. (2003). Associations between recommended levels of physical activity and health-related quality of life. Findings from the 2001 Behavioral Risk Factor

Surveillance System (BRFSS) survey. Preventive Medicine, 37(5), 520-528.

Bo-Ae Lee, Deuk-Ja Oh. Effect of regular swimming exercise on the physical composition, strength, and blood lipid of middle-aged women. Journal of Exercise Rehabilitation 2015;11(5):266-271.

Blagajac, M. (1989). Primena skala za subjektivnu procenu efekata programa u sportskoj rekreaciji. Zbornik radova IX ljetne škole pedagoga fizičke kulture, str. 146-152. Ohrid.

Duggal, N.A.; Pollock, R.D.; Lazarus, N.R.; Harridge, S.; Lord, J.M. Major Features of Immunesenescence, including Reduced hymic output, are ameliorated by High levels of Physical Activity in Adulthood. Aging Cell 2018, 17, 1–13. [CrossRef] PubMed]

Kinnunen, M., Kokkonen, M., Kaprio, J., & Pulkkinen, L. (2005). The associations of emotion regulation and dysregulation with the metabolic syndrome factor. Journal of Psychosomatic Research, 58(6), 513–521.

Kurko Ya.V. (2011). The influence of swimming performance on objective and subjective health of men. Pedagogics, psychology, edical-biological problems of physical training and sports. Vol. 6, 70-73.

Lampadari V., Chairopoulou C., Soultanakis H., Pyrpylis P., Thanopoulos V. (2016). Swimming and Water-Based Exercise for Adults: Effect on Body Weight, Body Fat and Lean Body Mass. Inquiries in Sport & Physical Education. Volume 13 (3), 0 – 62.

Lim, E-J., Hyun, E-J. The Impacts of Pilates and Yoga on Health-Promoting Behaviors and Subjective Health Status. Int. J. Environ. es. Public Health 2021, 18, 3802.

Neiva H. P., Fail L. B., Izkuierdo M., Markues M. C., Marinho D. A. The effect of 12 weeks of water-aerobics on health status and physical fitness: An ecological approach. PLoS One. 2018 May 31;13(5):e0198319. doi: 10.1371/journal.pone.0198319. eCollection 2018.

Marinović Glavić M, Mandić A., Juraga D, Vasiljev V, Rukavina T, Bilajac L. Samoprocjena zdravlja i funkcionalna sposobnost osoba treće životne dobi. Self-assessment of health and functional ability of the elderly. Med Jad 2020;50(4):285-291.

Omar J. S., Jaradat N., Qadoumi M. and Qadoumi1 A. N. Regular swimming exercise improves metabolic syndrome risk factors: a quasi-experimental study. Omar et al. BMC Sports Science, Medicine and Rehabilitation (2021) 13:22.

Penedo, F.J.; Dahn, J.R. Exercise and Well-being: A Review of Mental and Physical Health Benefits associated with Physical Activity. Curr. Opin. Psychiatry 2005, 18, 189–193. [CrossRef]

Seligman, M. E. P. (2008). Positive health. Applied Psychology, 57(s1), 3–18.

Sun S, Chen J, Johannesson M, Kind P, Burström K. Subjective well-being and its association with subjective health status, age, sex, region, and Socioeconomic characteristics in a Chinese population study. International Journal of Happiness

Studies. 2016 Apr;17(2):833-73.

Tanaka, H. Swimming Exercise. Sports Med 39, 377–387 (2009).

Vučković, S. (2003). Rekreativne aktivnosti u funkciji preventivno-zdravstvene usmjerenosti. X međunarodni naučni skup FIS KOMUNIKACIJE 2003. Niš: Fakultet sporta i fizičkog vaspitanja.

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Original scientific paper

Lifestyles related to NCD and utilization of preventive services among adults

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ABSTRACT: Leading behavioural risk factors for non communicable diseases (NCD) are smoking, harmful use of alcohol, physical inactivity and unhealthy diet. More than half of population between age 30 and 70 years die annually from NCDs which could be prevented by promotive and preventive measures.

Goal of the paper is to determine lifesyle factors related to non communicable diseases and utilization of preventive services in primary health care center Zvezdara in Belgrade. Survey is cross sectional study with sample size of 210 adults randomly selected. The analysis of the survey data was performed using the statistical data processing program SPSS 19.0 for Windows. Lifestyles factors related to NCDs among adult population in Belgrade are smoking (38,1%), alcohol consumption (32,9%), poor eating habits with high salt intake, more than 5g (29%) and inadequate frequency of meals (61%), sedentary lifestyles during working time (27,1%) and during leisure time (20,4%). Only 16,7% of population have moderate physical activity according to WHO recommentations. Preventive services utilized each third men and each fifth women, people with high level of education (p=0.001), professionals (p=0.007) who are living in good social conditions (p=0.000). Preventive services need to be organized more flexible in relation to public opinion using modern methods of health education via electronic services, media and mobile communications.

Key words: lifestyle factors, non communicable diseases, utilization of preventive health services.

INTRODUCTION

Non communicable diseases (NCD) are the main leading causes of death globaly, in the world, and are responsible for more than 41 milion of the world's deaths (71%). Burden of NCD is greatest in low and middle income countries, as well as in our country (Risk Factors Collaborators, 2016). Four leading behavioural risk factors which are caused NCD are smoking, harmful use of alcohol, physical inactivity and unhealthy diet (WHO, 2013). These risk factors lead to metabolic changes which increase risk of NCDs: raised blood pressure, overweight/obesity, raised blood glucose and raised blood lipids. Environmental risk factors are also leading causes of NCDs. Tobacco accounts for over 7,2 million deaths yearly, excess salt intake attributed to 4,1 million annual deaths, and more than 1,5 milion of deaths annualy are attributed to alcohol use and physical inactivity (Risk Factors Collaborators, 2015).

More than 36 milion of people die annually as a result of NCDs, including 15 million people who die too young between ages 30 and 70 years. The majority of premature NCD deaths in this age group belong to the four main noncommunicable diseases: cardiovascular diseases, cancer, diabetes and chronic respiratory diseases. All those diseases are preventable and through the preventive measures could be reduced risk for occurrence of diseases. The global target of WHO Global Action Plan is related to 25% of relative reduction of NCD diseases through reduction of risk factors influenting NCD diseases.

Prevalence of physical inactivity is more than double times higher in high income countries comparing to low income countries. Women are less active than men (WHO, 2018). WHO data from 2010

show that most people consume twice the daily recommended salt intake. Smoking rate was decreased and women smoked less than men, while one in three men currently smoke (WHO, 2018). According to WHO estimation more than 20% of population have raised blood pressure and 10% have raised blood glucose with a risk for developing diabetes.

In area of health promotive measures to reduce NCDs risks are provided general measures which include measures at the level of country and local community and specific measures related to population with risk factors. General measures are smoke-free indoor workplaces and public places, bans on tobacco advertising, restricted access to alcohol consumption, reduced salt intake in food and replacement of trans fat with polyunsaturated fat. Specific measures are related to counseling and preventive check ups. Counseling reduce high risk of developing heart attacks and stroke. For early prevention of cardiovascular diseases are recommended changes in behaviour in area of positive healthy lifestyle and anti aggregation drugs. Screening and treatment of pre-cancerous lesions could reduce the risks of developing leading cancers in burden of diseases (breast cancer, respiratory tract cancers and cancers of abdominal organs). Through implementing „Best buys“ initiatives by WHO could reduce 9,6 milion of premature deaths due to NCDs by 2025 (WHO, 2017).

Preventive measures in health care system are provided to reduction of risk factors for non communicable disesases. Preventive measures are universal oriented to whole population and selective which are oriented to vulnerable population groups (Strategy for public health in Republic of Serbia, 2018). Activites in Strategy are focused to quitting smoking and reduced alcohol consumption, counseling for healthy eating habits, promoting physical activity and preventive check ups for early identification of malignant diseases (Strategy for prevention and control of non communicable diseases in Republic of Serbia, 2009). According to Rule book on preventive services which are provided in health care system for adults aged 18 and older in primary health care are realized health promotive nad preventive measures and activities to reduce risk factors. Preventive activites providing by family medicine teams are preventive check ups of blood presure, antrhopometric measures and identification of smoking and substance abuse status (Ordinance on the content and scope of the right to health care from compulsory health insurance and participation for 2019). For obesity people and people with hypertension there are provided measurements of blood glucose and holesterol.

Prevalence of adult's smoking according to estimation of WHO in 2016 is 36% in Serbia which is similar to regional country, Bosnia and Herzegovina (38%). Prevalence of alcohol consumption among adults in Republic of Serbia is 49,3% (Ministry of Health of Serbia, 2019) but in Republic of Srpska 44,3% from which 16,8% of adults are daily consumers (Ministry of Health and Social Welfare of the Republic of Srpska, 2011).

Prevalence of physical inactivity according to WHO estimation among adults in Serbia is 41% which is for 15% more than in BiH (26%). People which are insufficient physical active have 20-30% more risks from premature death (WHO, 2010). According to national data, mean population salt intake among adults in Serbia is 9g/day, as well as in BiH and prevalence of obesity among adults is 24%.

Goal of the paper is to determine lifestyles factors related to non communicable diseases and utilization of preventive services in primary health care centre.

MATERIALS AND METHODS

Survey is cross sectional study of randomly selected people aged older than 18 who visited primary health care center in Zvezdara, one of Municipality in Belgrade, Serbia, during summer 2020 year. Sample size consisted of 210 of respondents who visited general practitioners in primary health care centers be-

tween 8AM-3PM (eight hours) without diagnosis of infectious diseases and noncommunicable diseases. Because of pandemic COVID 19 working conditions all patients had to wear mask and were in waiting room before formal invitiation to entry in ambulance.

One nurse was at the triage point giving the instructions abouts survey methodology and receiving formal consent from patients aggred to participate in survey. Each patient could break the survey in every moment according to ethical considerations. Mean time for completing questionarre was approximatelly 15 minutes. Special designed questionairre was constructed according to accesibility of proffesional and scientific studies and guidelines of World Health Organizations and European Health Interview Survey (EHIS). Independent variables used in survey are sociodemographic caracteristics: age (distributed with 10 years age groups), sex (female/male), level of education (primary, secondary, high and faculty), employment (unemployed, senior citizen, professionals, administrative staff and technical staff) and social status (poor, average and good). Dependent variables are divided according to possession of risk factors (smoking, alcohol abuse, physical inactivity and eating habits). Among questions about smoking we selected only daily smoking and daily alcohol consumption without number of consuming products. National study on population health in Serbia in 2019 selected those indicators according to European Core Health Indicators-ECHI indicators, to make it possible to compare the health of the population both this year and over the period of time. Frequency of food intake and salting food are selected between questions about eating habits and are direct risks for obesity and hypertension. Physical activity during working and leisure time are indicators recommended from WHO Global recommendations on physical activity for Health (2010) for examinations of main risks for NCD.

Utilization of primary health care services in area of health promotion (counseling and education in last 6 months) and preventive services consisted of check ups for early identification of risk factors for NCDs belong to domain of dependent variables. Health education methods are general public tools which patients can use according to physicians recommendations. Questions about usage of health education tools consisted of different types of health education methods and persons (health workers) who mostly recommendat that.

Statistical analysis consisted of statistical parametric and non parametric tests. Among the methods for assessing the significance of the differences between socio-demographic caracteristics and utilization of preventive services we used statistical chi-square test $\chi 2$, for nonparametric features. The analysis of the survey data was performed using the statistical data processing program SPSS 19.0 for Windows.

RESULTS

In survey are participated 210 of respondents, divided by sex, most of them in age group 30-39 years (24,76%), in average social conditions (48,10%) and with secondary level of education (44,76%) (Table 1).

Table 1. Distribution of respondents according to sex, age and social status

Sociodemographic characteristics	Variable	Number	Percent
Sex	Male	105	50
	Female	105	50
Age groups	18-29	35	16,66
	30-39	52	24,76
	40-49	37	17,62
	50-59	38	18,10
	60+	48	22,86
Social status	Poor	39	18,57
	Average	101	48,10
	Good	70	33,33
Level of education	Primary	5	2,38
	Secondary	94	44,76
	High	47	22,38
	Faculty	55	26,19
	Mr/PhD	9	4,29
TOTAL		210	100

Leading risk factors for NCDs among adults are smoking (38,1%) and alcohol consumption (32,9%) (Table 2). Eating habits are assesed according to regularity of meals and salt intake more than 5 gr. According to WHO for healthy eating habits are recommended 3 meals and 2 snacks and less than 5 grams salt intake daily. According to WHO recommendations for prevention of risk factors leading to NCDs and continuing promotion of healthy lifestyles, each person need a minimun 30-60 minutes of moderate physical activity during day. Moderate activities are riding a bike, fast walking, aerobic, running, swimming and other activities spending time to sweat and breathe (WHO, 2017).

More than half of respondents (61%) have irregular daily eating habits with daily intake less than 3 main meals and 2 snacks. Each fourth respondent takes three and more hours providing activities which are sedentary during daily working time and each fifth respondent takes sedentary lifestyle during leisure time (Table 2).

Table 2. Lifestyle and risk factors for NCD

Lifestile factors	Variable type	Yes Number	Percent	No Number	Percent
Smoking	Daily	80	38,1	130	61,9
Alcohol consumption	Daily	69	32,9	141	67,1
Regularity of meals	Daily	82	39	128	61
Salt intake more than 5 gr	Daily	61	29	149	71
Sedentary activites in working time	3 hours and more	57	27,1	153	72,9
Sedentary activities in leisure time	daily	43	20,4	167	79,6
Daily moderate physicial activity	30-60 minutes	35	16,7	175	83,3

At the level of primary health care, for adults older then 18, health care professionals provided preventive check ups in order to early identificate and reduce risk factors for NCDs. Preventive check ups are routine and basically associated with counseling for establishment and improvement of healthy lifestyle habits.

According to survey results, preventive services are utilized in primary health care by each third men and each fifth women (Table 3). Preventive services are provided mainly in age group of 30-39 years (30,4%) and among population older than 60 years (25%). According to the educational level, preventive services are mainly provided among population with faculty (41,1%) and high schools (35,7%). People living in good social conditions are mainly beneficiaries of preventive services (48,2%) and professionals who worked in different area of public business (42,9%) (Table 3).

Table 3. Utilization of preventive services according to sex, age, level of education and social status

Utilization of preventive services	Variable type	Yes Number	Percent	No Number	Percent	X2 p
Sex	Male	33	31,4	72	68,6	$\chi2$ =2.435
	Female	23	21,9	82	78,1	p=0.119
Age groups	18-29	10	17,8	25	16,5	$\chi2$ =13.384 p=0.146
	30-39	17	30,4	35	23,2	
	40-49	5	8,9	32	21,2	
	50-59	10	17,9	25	16,6	
	60+	14	25,0	34	22,5	
Level of education	Primary	1	1,8	4	2,6	$\chi2$ =18.688 p=0.001
	Secondary	12	21,4	82	53,3	
	High	20	35,7	27	17,5	
	Faculty	23	41,1	41	26,6	
Poor	Social status	9	16,1	30	19,5	$\chi2$ =25.43 p=0.000
	Average	20	35,7	81	52,6	
	Good	27	48,2	43	27,9	
Employment	Unemployed	9	16,1	38	24,7	$\chi2$ =25.874 p=0.007
	Senior citizen	6	10,7	23	14,9	
	Professionals	24	42,9	38	24,7	
	Administrative staff	6	10,7	32	20,8	
	Technical staff	11	19,6	23	14,9	

During realization of preventive services family physicians used different educational methods for counseling, giving instructions and demonstrate skills for early identification of risks factors for non-communicable diseases, developing controll mechanisms of diseases and giving instructions for adequate treatment of diseases. Most used health educational methods are media presentations (58,1% of men and 65,7% of women) but each eight male and female receive preventive messages through communication and printed materials (Table 4). People who are living in poor social conditions used printed materials more often then people living in average and good social environment. People with secondary level of education receive more than half of information about prevention, through communication with health professionals, but only one third people with high educational level degrees and each ten person with faculty. Transfer of preventive messages through media are the most popular method among population with different levels of educations, mainly high educated people, but printed material is also known as most popular method of giving healthy messages through brochures, leaflets and flyers (Table 4).

Table 4. Utilization of health educational methods in preventive services according to sex, social status and level of education (%)

Utilization of health educational methods	Variable type	Communication material	Media	Video presentation	Printed material	X2 p
Sex	Male	12,4	58,1	15,2	14,3	χ2 =2.020
	Female	12,4	65,7	9,5	12,4	p=0.568
Social status	Poor	2,6	71,8	2,6	23,1	χ2 =21.733
	Average	15.3	57,6	8,1	9,9	p=0.041
	Good	11,4	54.3	22,8	11,4	
Level of education	Primary	0	80	0	20	χ2 =36.271
	Secondary	53	75,5	8,5	10,6	p=0.000
	High	29,8	40,4	8,5	21,3	
	Faculty	10,9	56,3	21,9	10,9	

DISCUSSION

Smoking is associated with increased number of non communicable diseases, especially high blood presure and cardiovascular chronic diseases (Department of Health and Human Services, 2006). In eastern part of Europe and East Asia estimated that more than 60% of men and 40% of women smoked daily (Thun, 2012).

Prevalence of smoking among adult population in Republic of Serbia in 2019. is 39,3% (Ministry of health of Serbia, 2019) and in our study is 38,1%. Smoking rate among adults in Republic of Srpska is 28,7% (Ministry of Health and Social Welfare of the Republic of Srpska, 2011) but in Republic of Croatia is 27,4% of daily smokers among adults (Regional pattern of smoking in Croatia, 2009). The prevalence of cigarette smoking was higher in men (33.8%) than in women (21.7%).

Moderate alcohol consumption has been inversely associated with the risk of cardiovascular diseases and diabetes, although the benefits may be greater for persons with existing cardiovascular risk factors than for those without such risk factors (Roerecke, 2012).

The burden of diseases associated with alcohol consumption increased mainly from cancers, unintentional injuries, alcohol-related violence, neuropsychiatric and cardiovascular diseases especially in eastern part of Europe with a high prevalence of harmful drinking (Zaridze D, 2009). One third of population in our study consumed alcohol daily which is similar to WHO estimation of regional country data (WHO, 2016).

Overweight is responsible for about 3,4 million annual deaths and 3.8% of the global burden of diseases, and global prevalence of obesity (defined as a BMI ≥30) doubled in latest 30 years with increased prevalence of diseases such as diabetes and cardiovascular diseases (Ezzati, 2013; Stvenes, 2012). According to results presented in our study, adults are at risk for developing previously described non communicable diseases, specialy because of poor eating habits with irregularity of meals and high salt intake. More than half of adults in Serbia (56,6%) and 42,4% in Republic of Srpska have 3 main meals every day, data are from national studies. Every tenth person according to national study in Serbia and Republic of Srpska eat more than 5g salt daily but in our study approximately one third of respondents consumed salt daily.

Low dietary intakes of fruits, vegetables and high dietary intake of salt are individually risk factors responsible for more than 4% of the global disease burden (Lim, 2012). Many observational studies shown the benefits of lower fats and salt intake and healthy dietary patterns (He, 2013, Estruch, 2013). A high intake of salt is a risk factor for cardiovascular diseases. The most worrisome aspects of the Serbian diet were high intakes of saturated fat, sugar and sodium (Djurić, 2020). Study in BiH presented that people are living in high social conditions and youngers eat more sugar and sweets but people live in poor conditions

eat high fat dairy (Gičević, 2019). Accoridng to Croatian study the unhealthy dietary habits were practiced by approximately one quarter of the adult population. Prevalence of unhealthy dietary habits was higher in men in all regions (Jelinić Doko, 2009).

Preventive measures which are public oriented declined rates of hemorrhagic stroke and abdominal cancer. Finland is European country in which effective preventive measures are asocciated with lower salt intake declined rates of stomach cancer and hemorrhagic stroke (Toumilehto, 1984). Rate of sedentary lifestyle during usualy day in population of Republic of Serbia is 23% which is similar in our study where are 27% of adults sedentary during working time (only seating and working with PC and papers) and every fifth person is sedentary during leisure time. In Croatia, 35.8% of the population are physically inactive. Physical inactivity is higher in men than in women (43.7% vs 30%). During leisure time, 56,5% of men and 47,6% of women are inadequately physically active (Duraković-Misigoj, 2007). Moderate physical activity during period of 30-60 minutes have 16,7% of adults which is more for 5,6% than among population in national study. More than two third of population in Republic of Srpska are usualy sedentary with 10% of people use moderate physical activity daily, data are from national study.

According to survey results, male use preventive services (33%) more than female (23%). In BiH preventive services used female more than male (Kurspahić-Mujčić, 2019). Higher level of education and better social conditions are related to often utilization of preventive health services, data are from European study (Jusot, 2012) as well as in our study, preventive services are mainly provided among population with faculty (41,1%) and better social condtitions (48,2%). Utilization of media in providing health promotive and preventive services are most important health educational method in our study. Despite the low uptake of preventive interventions, more than two third of beneficiaries of preventive services are interested in remote access to preventive services using telemedicine platforms and e-consultations, data are from Poland (Agrawal, 2021). Social trend in communication using mobile applications and other media will have positive impact on communication in health services in area of health promotion and diseases prevention.

CONCLUSION

Lifestyles factors among adult population in Belgrade are smoking (38,1%), alcohol consumption (32,9%), irregularity of meals (61%) and more salt intake (29%). Physical activity is inadeqate by 16,7% of population who had daily moderate activity during 30-60 minutes had 16,7% of population. Sedentary activities during working time had 27,1% and during leisure time 20,4%. Preventive services utilized each third men and each fifth women, mainly in age groups 30-39 years (30,4%) and among population with faculty (41,1%). People living in good social conditions are mainly beneficiaries of preventive services (48,2%). Preventive services need to be organized more flexible in relation to public opinion. Consultation and health education could be organized via modern communication technologies, mobile applications and electronic communications. On that way obstacles in access to preventive services would be overcome and it would increase coverage of preventive health services.

REFERENCES

Risk Factors Collaborators (2016). Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study. Lancet, 388 (10053), 1659-1724

World Health Organization (2013). Global Action Plan for Prevention and Control of NCD 2013-2020. Geneva, World Health Organization.

World Health Organization (2018). Noncommunicable diseases. Country profiles 2018. Geneva, World Health Organization.

World Health Organization (2017). „Best buys“ and other recommended interventions for the prevention and control of noncommunicable diseases. Geneva: World Health Organization.

Strategy for public health in Republic of Serbia, 2018-2026 (2018). Official Gazette of Republic of Serbia 61/2018

Strategy for prevention and control of noncommunicable diseases in Republic of Serbia (2009). Official Gazette of Republic of Serbia 22/2009

Ordinance on the content and scope of the right to health care from compulsory health insurance and participation for 2019. Official Gazette of Republiv of Serbia 07/2019

Department of Health and Human Services (2006). The health consequences of involuntary exposure to tobacco smoke. National Center for Chronic Disease Prevention and Health Promotion. Atlanta.

Thun M, Peto R, Boreham J, Lopez AD (2012). Stages of the cigarette epidemic on entering its second century. Tob Control, 21, 96-101

Ministry of Health of Serbia (2021). Survey on population health in Serbia in 2019. Public Health Institut of Republic of Serbia. Beograd. Available at: https://publikacije.stat.gov.rs/G2021/pdf/G20216003.pdf .Accessed 01.10.21

Ministry of Health and Social Welfare of the Republic of Srpska (2011). Survey on population' health in Republic of Srpska. Public health Institute of Republic of Srpska. Banja Luka.

World Health Organization (2010) . Global recommendations on physical activity for Health: Geneva, WHO.

Roerecke M, Rehm J (2012). The cardioprotective association of average alcohol consumption and ischaemic heart disease: a systematic review and meta-analysis. Addiction, 107, 1246-1260

Zaridze D, Brennan P, Boreham J, et al (2009). Alcohol and cause-specific mortality in Russia: a retrospective case-control study of 48,557 adult deaths. Lancet;373, 2201-2214

Ezzati M, Riboli E (2013). Behavioral and Dietary Risk Factors for Noncommunicable Diseases. New England Journal of Medicine, 369, 954-964

Stevens GA, Singh GM, Lu Y, et al (2012). National, regional, and global trends in adult overweight and obesity prevalences. Popul Health Metr,10, 22-22

Lim SS, Vos T, Flaxman AD, et al (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet,380, 2224-2260

He FJ, Li J, Macgregor GA (2013). Effect of longer term modest salt reduction on blood pressure: Cochrane systematic review and meta-analysis of randomised trials. British Medical Journal, 346.

Estruch R, Ros E, Salas-Salvado J, et al (2013). Primary prevention of cardiovascular disease with a Mediterranean diet. New England Journal of Medicine, 368:1279-1290

Tuomilehto J, et al (1984). Trends in stomach cancer and stroke in Finland: comparison to northwest Europe and USA. Stroke, 15, 823-828

Samardžić S, Marvinac Vuletić G, Prlić A (2009). Regional pattern of smoking in Croatia. Coll Antropol, 1, 43-6

Duraković-Misigoj M, Heimer S, Gredelj M, Zeljko H, Sorić M (2007). Physical inactivity in Croatia. Acta Med Croatica, 61(3), 253-8.

Djurić Z et al (2020). Association of meal timing with dietary quality in a Serbian population sample. BMC Nutrition, 45

Gicevic S et al (2019). Demographic and socio-economic predictors of diet quality among adults in Bosnia and Herzegovina. Public Health Nutrition, 22 (17), 3107–3117

Jelinić Doko J et al (2009). Regional Differences in Dietary Habits of Adult Croatian Population. Coll. Antropol. 33 Suppl. 1, 31–34

Kurspahić-Mujčić A, Mujčić A (2019). Preventive health services utilization in patients treated byfamily physicians. Med Glas, Zenica; 16 (2)

Jusot F, Or Z, Sirven N (2012). Variations in preventive care utilisation in Europe. Eur J Ageing, 9, 15–25

Agrawal S, Golebiowska J, Makuch S, Mazur G (2012). Prevalence of Use of Preventive Services in Poland: Result from a Population-Based Nationwide Study. Journal of Clinical Medicine, 10, 2084

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Original scientific paper

Air Quality in the Town of Bijeljina - Trends and Levels of So_2 and No_2 Concentrations

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ABSTRACT: Abstract: The paper presents results of the measurements of the sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) concentration and meteorological parameters: temperature, air pressure, relative humidity and wind speed. The data were collected from January 2019 to December 2020 at two stations, namely Center and Heating plant, in the City of Bijeljina, Republic of Srpska, Bosnia and Herzegovina. SO_2 and NO_2 are one of the major air pollutants that could negatively affect the human health. Levels of SO_2 and NO_2 in air samples and meteorological variables from urban zone of Bijeljina were determined at both localities, which represent a highly-populated area with intensive traffic. This topic has not been studied up to now in Bijeljina, although the recent research data indicates that there is a correlation between meteorological parameters and air pollutants. Statistical analysis confirms direct corelation between SO_2 and NO_2 and meteorological parameters, specially temperature in locality Center (r = -0.639), the wind speed in locality Heating plant (r = 0.399) and relative humidity (r = 0.162). Correlation of NO_2 with temperature is not confirmed in both localities. The wind speed increase is followed by rises of the NO_2 concentration values and vice versa. Correlation of NO_2 with pressure is confirmed in locality Center (r = 0.128) but it is not confirmed in locality Heating plant. Correlation between NO_2 and relative humidity found to be negative in locality Center (r = -0.062). These parameters are the most important meteorological factors influencing the variation in SO_2 and NO_2 concentration in the air during the research. Depending on the obtained correlation, meteorological parameters had a positive or negative impact on air pollution.

Keywords: air quality, sulfur dioxide (SO_2), nitrogen oxides (NO_x), nitrogen dioxid (NO_2).

INTRODUCTION

Air pollution can be defined as the emission of various gases, particulate matters, biological materials, and other pollutants into the atmosphere. The sources of emissions could be natural and anthropogenic (Stanek & Brown, 2019). Natural sources include physical disasters, such as forest fires, volcanic eruptions, dusty storms and various agricultural activities (Barbosa et al., 2008; Von Glasow et al., 2009; Prato & Huertas, 2019). Anthropogenic sources produce most of the environmental pollutants and, they could be stationary and mobile sources (Fino, 2019). Stationary sources include all activities related to the combustion of fossil fuels in the production of electricity or heat, the combustion of fossil fuels in production processes, emissions from households and waste incinerators, furnaces, and other heating devices, traditional biomass combustion, various industrial plants, mining and agricultural activities (Cardu & Baica, 2005; Ge et al., 2004; Yadav & Devi, 2019; Pandey et al., 2014). Since these activities are performed on a large scale, they contribute the most to air pollution. Mobile sources include all types of transport vehicles: motor vehicles, trains, ships, and planes (Hesterberg et al., 2006; Abbasi et al., 2013; Mueller et al., 2011). Among the anthropogenic sources of air pollution, the most important are thermal power plants, industrial and domestic furnaces that use fossil fuels to obtain electricity or heat and means of transport. Industrial and domestic heating stoves have a seasonal character, while thermal power plants pollute the atmosphere

throughout the year. The greatest influence of individual fireplaces on the air quality in our region is from October to May. Regardless of the source, pollutants have a considerable impact on the living world and the environment. Some of them cause diseases and even death, lead to reduced visibility, block sunlight, cause acid rain, ozone holes, damage materials and infrastructure, damage ecosystems, cause climate promenades that affect the entire planet (Ramanathan & Feng, 2009; Maduna & Tomašić, 2018).

According to World Health Organization (WHO) estimates, about seven million people die each year from air pollution. WHO data show that 9 out of 10 people breathe air in which the WHO guidelines for air pollutants are exceeded, and low-and middle-income countries suffer from the major exposure. Air pollution poses a serious threat to health and the climate. The combined effect of ambient and indoor air pollution causes about seven million premature deaths each year. That is an outcome of increased mortality from stroke, heart disease, chronic obstructive pulmonary disease, lung cancer, and acute respiratory infections. Estimations say that about 4.2 million deaths per year are the result of exposure to polluted ambient air, and 3.8 million deaths per year are the result of polluted indoor air (www.who.int/health-topics/air-pollution#tab=tab_1; www.who.int/phe/eNews_63.pdf).

The law defines the control of emitters of pollutants at the point of discharge, and it is necessary to carry out a series of complex technological procedures to achieve the prescribed permitted emission levels. National legislation defines allowable concentrations of pollutants emitted from stationary sources and allowable emissions of pollutants in ambient air (Regulation 124/12; Directive 2008/50/EC; Rulebook 3/15, 51/15, 47/16 and 16/19). Different compounds (gases, liquids, and solid particles) can appear in the air as pollutants. The most common pollutants that appear in the air of urban areas are sulfur oxide (SO_x), nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter (PM_{10} and $PM_{2.5}$), ground-level ozone (O_3), volatile organic compounds (VOCs), photochemical oxidants, lead, dust or aerosediment, soot, etc (Manisalidis et al., 2020). The WHO offers global guidelines on thresholds and limits for key air pollutants that pose a health risk. The guidelines are applied worldwide, and they are based on expert assessment of current scientific evidence for PM_{10}, $PM_{2.5}$, O_3, nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) (www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health).

During the combustion of fossil fuels, a mixture of different pollutants is emitted. Oxides of sulfur and nitrogen are emitted to a significant extent. SO_x originate from the sulfur present in fossil fuels or ores, while NO_x are formed at high temperatures due to the reaction between nitrogen and oxygen from the air. The most common SO_x are SO_2 and SO_3. NO_x primarily produce nitrogen monoxide (NO), which oxidizes to NO_2. After discharge from coal-fired power plants and motor vehicles, SO_2 and NO_x may have sufficient time to transform into sulfuric and nitric acid under favorable atmospheric conditions, especially in the presence of water vapor. Monitoring the concentration of SO_2 is important because of its potential to be converted into sulfuric acid (H_2SO_4), and because of the harmful effects on metals, building and construction materials, urban ecosystems, vegetation and human health. (Đuković & Bojanić, 2000; Ilić, 2015). Monitoring of NO_2 concentration is important due to its constant emission during the combustion process at high temperatures, negative impact on wildlife, vegetation and human health, and the occurrence of acid rain due to conversion to nitric acid. In the presence of hydrocarbons increases the impact of NO_2 on photochemical ozone occurence (Warmiński & Bęś, 2018).

Although other pollutants have the detrimental effect on air quality, in this paper attention is focused on SO_2 and NO_2, because these are gases emitted in large quantities from different stationary and mobile sources, and they have a proven harmful effect on materials, wildlife and human health, affect the formation of acid rain (Grennfelt et al., 2020), and NO_x participate in the formation of ozone (Warmiński & Bęś, 2018). In this paper, SO_2 and NO_2 emissions are monitored continuously, to obtain information on the concentration

of selected gases during the year at selected measuring points, depending on local weather conditions.

Allowable concentrations of SO_2 and NO_2 in European countries were given by Directive 2008/50/EC (Directive 2008/50/EC), which was also accepted by the Republic of Srpska government (Regulation, 124/12). Allowable concentrations of SO_2 and NO_2 in ambient air on an hourly, daily, and annual basis in Republic of Srpska are 350 μg/m^3 and 150 μg/m^3 (1-hour mean), 125 μg/m^3 and 85 μg/m^3 (24-hour mean) and 50 μg/m^3 and 40 μg/m^3 (annual mean), respectively. Concentrations of SO_2 and NO_2 dangerous to human health are 500 μg/m^3 and 400 μg/m^3, respectively (Regulation, 124/12). The latest WHO guideline value for SO_2 is 40 μg/m^3 24-hour mean. WHO guideline values for NO_2 are 25 μg/m3 24-hour mean and 10 μg/m^3 (annual mean) (for protecting the public from the health effects of gaseous NO_2) (www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health).

This paper aims to assess the air quality in Bijeljina based on monitoring the content of SO_2 and NO_2 in the air, identifying sources and causes of increasing pollutant concentrations during the year, and determining the correlation between pollutants and meteorological parameters.

MATERIALS AND METHODS

Location

Air quality testing was performed at locations marked „Center" and „Heating Plant" in Bijeljina. The test was performed according to the principle of 24-hour sampling, from January 2019 to the end of 2020 at the planned measuring points. The location marked „Center" is located in the city center (Karađorđeva street, 44° 45′ 24,43′′ N, 19° 13′ 6,53′′ E). The nearby area includes busy streets, service facilities (city administration, banks, shopping malls, and restaurants), cultural and educational facilities (Semberija Museum, schools), religious buildings, residential buildings, and a bus station. Traffic is the predominant source of emissions. The location marked as „Heating plant" is located in the industrial zone, in Sremska street 44° 45′ 41,88′′ N, 19° 12′ 21,28′′ E. The close vicinity of this location includes busy streets, shopping malls, a gas station, service, and residential buildings so that the predominant sources of emissions can be identified as heating plants and traffic.

Figure 1. Location "Center" (source: Google Earth)

Figure 2. Location "Heating plant" (source: Google Earth)

The heating plant has a heat source of 2 boilers with a capacity of 3.8 MW, which gives 7.6 MW (Work plan, 2017). By calculation, it can be obtained that for the heating season from October to March, for boilers with a total capacity of 7.6 MW, 4000 t of coal are needed. According to 2019 data, slightly more than 4,000 tons of coal were procured, as follows: separated cube 500 t, separated walnut 500 t, coal cubes 3,000 t, lignite coal 150 t, and brown coal cube 250 t (Procurement plan, 2019).

Analytical procedure

Teledyne Advanced Pollution Instrumentation, Inc. (TAPI) Sad Diego, California, United States, model T100 (UV Fluorescence SO_2 Analyzer) of the range 0-200 ppb, has been used for measuring SO_2 concentrations and Model T200 (Chemiluminescence $NO/NO_2/NO_x$ Analyzer) for NO_2, of the range 0-50 ppb. Monitoring of SO_2 was performed following standard BAS EN 14212, as the reference method and BAS EN 14211 for NO_2 (BAS EN 14212). Presented data were recorded under the ambient temperature, where simultaneously have been measured meteorological parameters: air pressure, wind speed and relative humidity. At the meteorological monitoring site along the border of the city every day during the research period meteorological parameters have been recorded. The measured concentration of pollutants was compared with actual values, defined by regulations regarding air quality, issues on pollution and air quality control. Based on both data along with Regulation on air quality values (Regulation, 124/12), Directive 2008/50/EC on ambient air quality and cleaner air for Europe (2008/50/EC) as well as standards recommended by WHO and EU countries, an assessment of the current state will be given. The present study gives a review of the existing conditions via representing relevant parameters and discusses the position of their amount in the range of recommended as well as limit values specified by the mentioned legislation.

Statistical analysis

For the determination of the interdependence and relationship between SO_2 and NO_2 of air quality, the Excel 2016, JASP Computer software (JASP, 2021), and Wessa Statistics Software 1.2.1 were used (Wessa, 2021) for statistical data processing. Descriptive statistical operations like mean, median, mode, standard deviation (SD), variance, minimal (min) and maximal (max). Skewness, Kurtosis and Shapiro-Wilk test value have been applied to analyse the measured data. Also, correlation analysis was performed and the bagplots are shown.

RESULTS AND DISCUSSION

The mean annual value of SO_2 concentration in order to preserv human health amounts 50 μg/m^3 (2008/50/EC; Regulation, 124/12) (Table 1). Measured average values of SO_2 are shown in Table 1, together with maximal and minimal values, median, mode, standard deviation and variance. In a research field, it did not exceed and amounts 19.39 μg/m^3 (locality Center) and 25.06 μg/m^3 (locality Heating plant) (Table 1). The usual values of SO_2 in urban areas usually range from 20 to 100 μg/m^3 (Ilić et al., 2008; Ilić & Janjuš, 2008; Ilić, 2009; Ilić et al., 2010), while in areas far from any human activity the natural level of SO_2 is below 5 μg/m^3 (Jablanović et al., 2003). Daily and hourly concentrations in urban areas, as in the case of Bijeljina, are higher than the usual average of 20-50 μg/m^3. Considering that there are no published publications from the previous period, a comparison was made with the values from Banja Luka City. Measurements in Banja Luka are performed at similar locations as in Bijeljina, in the center next to the busy road, near the City Heating Plant, so the sources of pollution in both cities are similar. Research conducted in the area of Banja Luka, in terms of SO_2 content in the air, showed that Banja Luka is a zone with slightly polluted and unpolluted air. There is no significant impact on people, flora, fauna, and natural and material goods (Ilić et al., 2009), with an

average annual SO_2 value of 10.14 μg/m^3. This indicates that the investigated area in Banja Luka is not overburdened with this pollutant, and the values are below the limits that most often occur in the urban area (Ilić et al., 2008; Ilić & Janjuš, 2008; Ilić, 2009; Ilić et al., 2010). Higher values were measured during later research and the annual value is 21.81 μg/m^3 (Ilić, et al., 2018), whereas the prime cause is the increase in the number of vehicles in the city. As in the case of Bijeljina, in the case of Banja Luka, the highest concentrations were recorded during the winter period, due to intensive combustion of sulfur-containing fuels and traffic (Ilić et al., 2008), while during the summer period an extremely low average monthly value was recorded. Daily variations are directly connected to the regime and intensity of traffic and using fossil fuels. During a day, population activities such as traffic frequency increase, and this causes the concentration of polluting substance SO_2 to grow, but probably and sulfur trioxide and sulfuric acid. Thus, under the right conditions, SO_3 can lead to the formation of sulfuric acid, a strong irritant and corrosive agent. Ultimately, sulfuric acid is formed in water droplets from the interaction of SO_2 and hydroxyl radicals (OH•) (Ilić et al., 2018).

The mean annual value of NO_2 concentration in order to preserve human health amounts 40 μg/m^3 (2008/50/EC; Regulation, 124/12). Measured average values of NO_2 at measuring points in Bijeljina are shown in Table 1, together with maximal and minimal values, median, mode, standard deviation and variance. In a research field, average values are 45.04 μg/m^3 (locality Center) and 55.62 μg/m^3 (locality Heating plant). Measured NO_2 concentrations, with annual mean concentrations above 18.82 μg/m^3, which is the case in Bijeljina, indicate the dominance of traffic and urban sources in air pollution (RoTAP, 2012). During the research in the area of Banja Luka, the average annual value for NO_2 was 46.08 μg/m^3 (Ilić, 2009, Preradović et al., 2010), indicating polluted air, similar to Bijeljina. The value of NO_2 concentration in the air was exceeded in 2007, when the average annual value was 63.09 μg/m^3 (Erić et al., 2008). A lower average annual value was recorded during 2015-2017, which amounted to 28.23 μg/m^3 (Ilić et al., 2019). Comparing the results of measured values of SO_2 and NO_2 in Bijeljina, with the results obtained for measurements conducted in Banja Luka (Ilić et al., 2009), it is clear that the air quality in Bijeljina is worse. This indicates that in the measuring areas in Bijeljina there are significant sources of pollution, such as heating plants, individual combustion plants that use coal of poorer quality as fuel and the proximity of busy roads. Multiple increases in the concentration of SO_2 and NO_2 in Bijeljina during the winter months can be attributed to the direct impact of increased combustion of fossil fuels during the heating season, as is the case in Banja Luka.

Table 1. Statistical summary of SO_2 and NO_2 and meteorological variables in localities Center and Heating plant in Bijeljina City (2019-2020)

	Center SO_2	Heating plant SO_2	Center NO_2	Heating plant NO_2	Center VW m/s	Heating plant VW m/s	Center P bar	Heating plant P bar	Center T (0C)	Heating plant T (0C)	Center RH%	Heating plant RH%
Valid	730	732	730	732	731	731	731	731	731	731	731	731
Mean	28.431	23.770	47.256	46.656	1.567	1.597	975.881	993.570	10.009	13.773	86.484	87.624
Median	19.395	25.061	45.038	55.624	1.200	1.210	973.736	994.123	9.907	11.690	89.989	90.516
Mode	8.839	26.421	17.237	14.130	1.220	0.600	24.245	990.160	-10.38	99.900	99.900	99.900
Std. Deviation	22.033	7.053	21.866	23.057	1.244	1.242	38.210	10.076	9.654	17.325	35.987	12.887
Variance	485.444	49.739	478.112	531.639	1.547	1.543	1459.968	101.532	93.201	300.173	1295.060	166.083
Skewness	2.318	-0.031	0.075	-0.168	2.058	2.062	-21.147	-0.102	0.186	3.052	19.827	-1.182
Kurtosis	7.040	0.422	-1.809	-0.572	5.137	5.147	528.497	0.730	-0.017	11.403	485.374	1.400
Shapiro-Wilk	0.751	0.959	0.812	0.884	0.791	0.790	0.230	0.990	0.956	0.674	0.260	0.864
Minimum	8.839	8.062	17.237	7.780	0.230	0.250	24.245	960.517	-10.38	-8.568	25.649	29.790
Maximum	180.039	55.014	80.922	146.803	8.400	8.420	1026.347	1028.928	63.781	99.900	99.987	99.900

Although extremely high levels of SO_2 and NO_2 have not been recorded during the investigated period, humidity during the analyzed period of 86.49% (locality Center) and 87.62% (locality Heating plant). Due to several chemical reactions in which SO_2 and NO_2 are converted into sulfur and nitrogen acid, it can affect the increase in harmful effects caused by the action of SO_2 and NO_2.

Figures 3 and 4 show the trend of the presence of SO_2 pollutants by months for both years of research. The level of SO_2 concentration is significantly higher in the winter compared to the summer months, which confirms that the use of fossil fuels is a significant source of this pollutant. The concentration of SO_2 in the area of the heating plant during the heating season is significantly higher compared to the measured concentration at the measuring point Center. That can be attributed to the direct impact of the heating plant on air quality. During the rest of the year, the concentrations of SO_2 at both measuring points are equal, as the seasonal sources of pollution (heating plants and individual furnaces) are not operative. The levels of SO_2 at both measuring points during the summer season (April-September) are even, which indicates that the predominant sources of air pollution in that interval are the exhaust gases of motor vehicles.

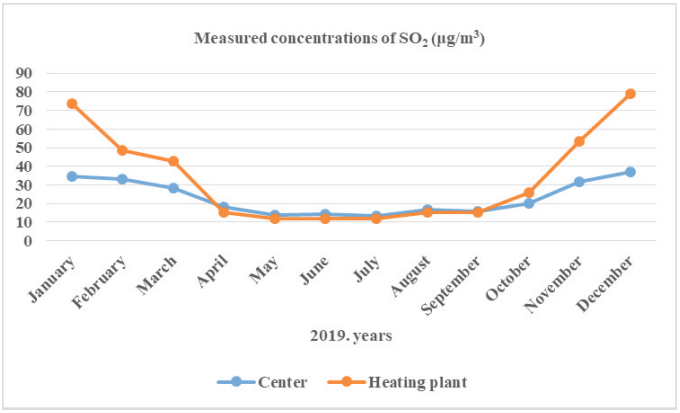

Figure 3. Graphic representation of measured SO_2 concentrations (µg/m³) in 2019

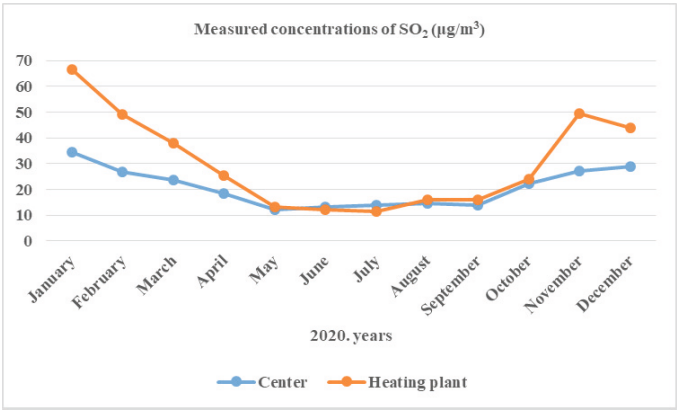

Figure 4. Graphic representation of measured SO_2 concentrations (µg/m³) in 2020

Figures 5 and 6 show the trend of NO_2 presence by months for both years of the study. The level of NO_2 concentration is uniform during winter and summer periods, which indicates that the source of this pollutant is related to human activities, primarily related to traffic. NO_x concentrations are in a wide concentration range, depending on geographical areas. Nitric oxide content in urban areas is high compared to non-urban areas. These concentrations, which vary depending on the region, regarding the emission intensity, also vary during the day. Variations in NO_2 levels predominantly depend on human activity during the day, month, and meteorological conditions. Thus, for example, nitric oxide concentrations in the early morning hours without solar insolation are generally constant. As the activity of the population changes during the day, the frequency of traffic increases, and the concentration of NO, as the primary pollutant, increases (Thomas & St. John, 1958; Ilić & Preradović, 2009; Ilić & Maksimović, 2021). The concentration of NO_2 at both measuring points is uniform throughout the year, with the measured concentrations at the measuring station of the Heating plant being higher concerning the location of the Center, which supports the claim that that location is an additional source of pollution of Heating plant.

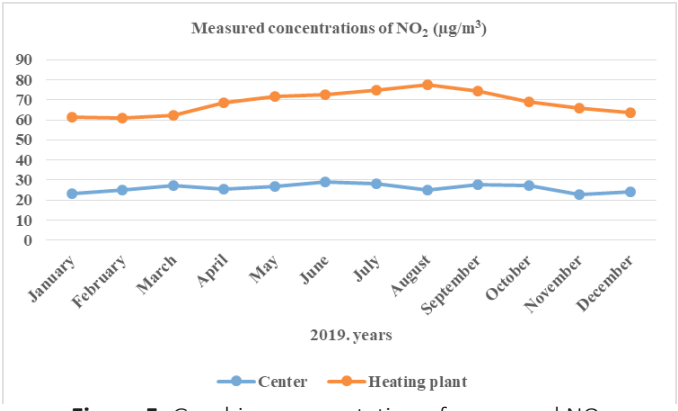

Figure 5. Graphic representation of measured NO_2 concentrations (µg/m³) in 2019

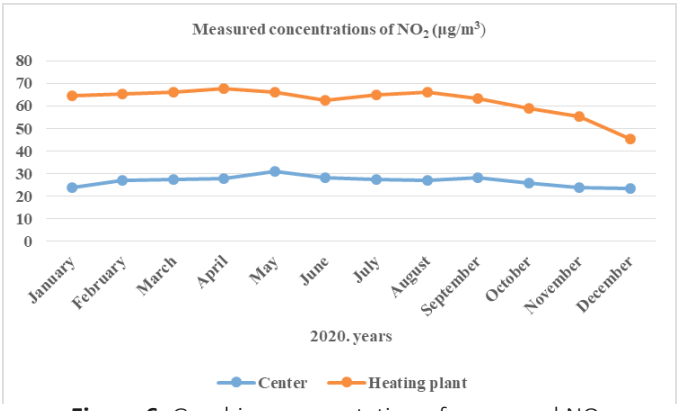

Figure 6. Graphic representation of measured NO_2 concentrations (µg/m³) in 2020

Each meteorological factor plays a unique role in explaining variations of pollutants through its particular response or effect (Vasiliauskienė et al., 2016). The influence of meteorological parameters on ambient air quality is significant (Gong et al., 2015). The relationship between SO_2 and NO_2 concentrations and meteorological factors for two included locations in the City of Bijeljina was analyzed using the correlation technique. The results of the correlation analysis between the SO_2 and NO_2 concentration and meteorological parameters are shown for the level of significance $p < 0.001$ and $p < 0.01$ (Table 2). Temperature, air pressure and relative humidity are meteorological factors with the strongest impact on the SO_2 and NO_2 concentration level (Zhang, et al., 2015; Jayamurugan et al., 2013; Liu et al., 2020).

Table 2. Correlation coefficients between SO_2 and NO_2 concentrations and meteorological variables

		Pearson			Spearman			Kendall		
		r		p	rho		p	tau B		p
Centar SO_2	- Centar NO_2	0.110	**	0.003	-0.275	***	0.001	-0.171	***	0.001
Centar SO_2	- Centar VW m/s	-0.014		0.713	-0.038		0.306	-0.019		0.453
Centar SO_2	- Centar P bar	0.131	***	0.001	0.192	***	0.001	0.130	***	0.001
Center SO_2	- Center T (^{0}C)	-0.639	***	0.001	-0.737	***	0.001	-0.505	***	0.001
Centaer SO_2	- Center RH%	0.162	***	0.001	0.520	***	0.001	0.357	***	0.001
Center SO_2	- Toplana SO_2	0.164	***	0.001	0.109	**	0.003	0.078	**	0.002
Center NO_2	- Center VW m/s	0.565	***	0.001	0.650	***	0.001	0.442	***	0.001
Center NO_2	- Center P bar	0.128	***	0.001	0.249	***	0.001	0.151	***	0.001
Center NO_2	- Center T (^{0}C)	-0.031		0.400	0.107	**	0.004	0.093	***	0.001
Center NO_2	- Center RH%	-0.062		0.093	-0.127	***	0.001	-0.083	**	0.001
Center NO_2	- Heating plant SO_2	0.398	***	0.001	0.327	***	0.001	0.240	***	0.001
Center NO_2	- Heating plant NO_2	0.662	***	0.001	0.544	***	0.001	0.372	***	0.001
Heating plant SO_2	- Heating plant NO_2	0.801	***	0.001	0.737	***	0.001	0.547	***	0.001
Heating plant SO_2	- Heating plant VW m/s	0.399	***	0.001	0.534	***	0.001	0.387	***	0.001
Heating plant SO_2	- Heating plant P bar	-0.014		0.708	-0.019		0.603	-0.013		0.595
Heating plant SO_2	- Heating plant T (^{0}C)	-0.067		0.071	-0.230	***	0.001	-0.154	***	0.001
Heating plant SO_2	- Heating plant RH%	0.051		0.168	0.037		0.314	0.029		0.246
Heating plant NO_2	- Heating plant VW m/s	0.455	***	0.001	0.614	***	0.001	0.437	***	0.001
Heating plant NO_2	- Heating plant P bar	-0.055		0.137	-0.101	**	0.006	-0.064	**	0.010
Heating plant NO_2	- Heating plant T (^{0}C)	-0.034		0.358	-0.160	***	0.001	-0.105	***	0.001
Heating plant NO_2	Heating plant RH%	-0.039		0.295	-0.060		0.107	-0.033		0.195

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

We found a negative correlation between SO_2 in locality Center and temperature (r = -0.639), which implies the significant use of fossil fuels at low temperatures in individual furnaces. At the location of the Center, the correlation was not confirmed, which indicates the dominant influence of traffic and constant pollution, regardless of the meteorological parameters. The statistical analysis confirms that when the temperature drops, there is an increase in pollution, as there is increased consumption of fossil fuels, which is the cause of enlargement in the concentration of SO_2. Temperature decrease is followed by rises of the SO_2 concentration values, i.e. and vice versa. Correlation between temperature and SO_2 concentration in location Center is confirmed by the Pearson's, Spearman's and Kendall's Rank Correlation Coefficient and presented in Table 2; Fig. 7. Positive correlation of SO_2 concentrations with the wind speed is significant in locality Heating plant (r = 0.399, Table 2, Fig. 8). The wind speed increase is followed by rises of the SO_2 concentration valuesand vice versa. This indicates that the source of pollution is probably from other areas, more precisely from urban settlements with individual fireboxes.

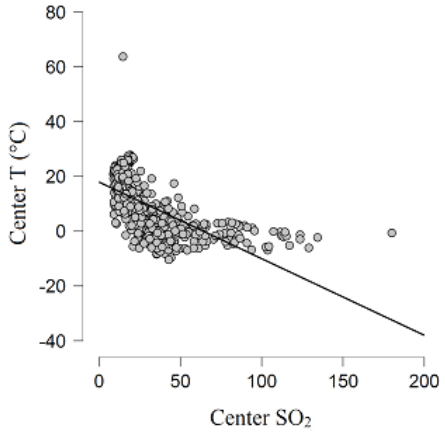

Figure 7. Correlation between SO_2 concentrations and temperature in location Center

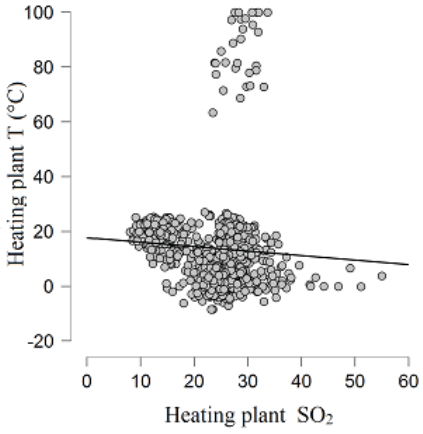

Figure 8. Correlation between SO_2 concentrations and temperature in location Heating plant

Correlation between SO_2 and relative humidity was found to be positive (r = 0.162, Table 2), which implies that increasing of the SO_2 concentration is followed by increasing of relative humidity, and vice versa. From the data collected during the study period, SO_2 concentration dependence on the relative humidity is obtained and shown in Fig. 9 and 10. The correlation was also confirmed by the Pearson's, Spearman's and Kendall's Rank Correlation Coefficient and given in Table 2. The humidity level is highest in the winter. At the same time, there is the highest consumption of fossil fuels, as well as the highest emissions of pollutants.

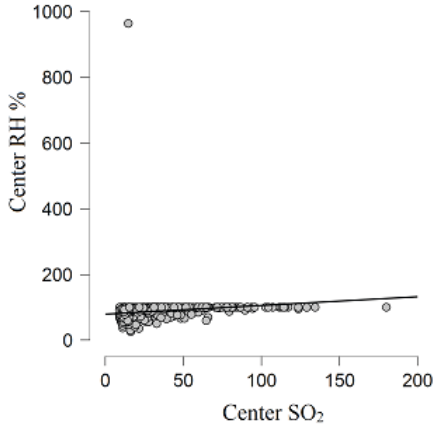

Figure 9. Correlation between SO_2 concentrations and relative humidity in location Center

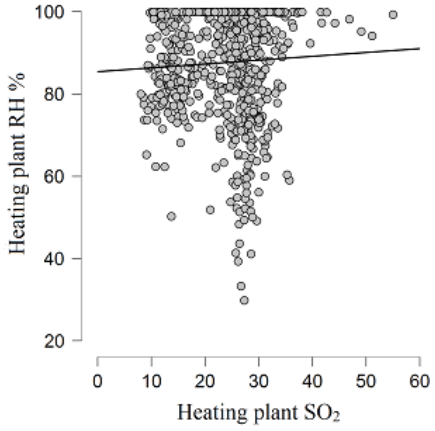

Figure 10. Correlation between SO_2 concentrations and relative humidity in location Heating plant

Relative humidity was found as animportant parameter with a strong impact on the reactivity of the system, by affecting the production of wet aerosols, which in turn affect the ultraviolet actinic flux. It can be a restrictive factor in the disposition of NO_2 because high percentages of humidity favor the reaction of NO_2 with particles of Sodium chloride (Dueñas et al., 2002). Correlation between NO_2 and relative humidity was found to be negative in locality Center (r = - 0.062, Table 7), which implies that lowering of the NO_2 concentration is followed by the increase of relative humidity and vice versa. From the data collected during the study period, NO_2 concentration dependence on the relative humidity is obtained and shown in Fig. 11. Negative correlation was also confirmed by the Pearson's, Spearman's and Kendall's Rank Correlation Coefficient and given in Table 2. In locality Heating plant correlation was not confirmed (Fig. 12).

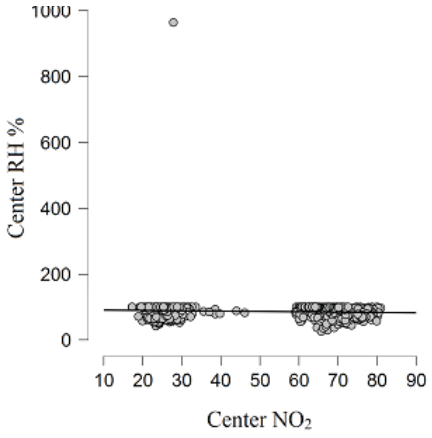

Figure 11. Correlation between NO_2 concentrations and relative humidity in location Center

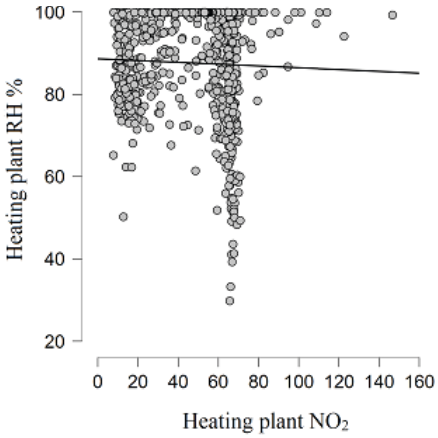

Figure 12. Correlation between NO_2 concentrations and relative humidity in location Heating plant

Correlation NO_2 with temperature was not confirmed in both localities (Fig. 13 and 14).

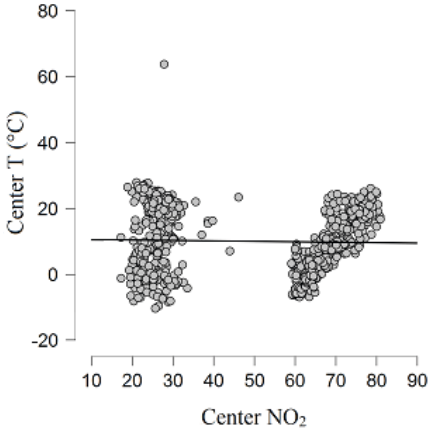

Figure 13. Correlation between NO_2 concentrations and temperature in location Center

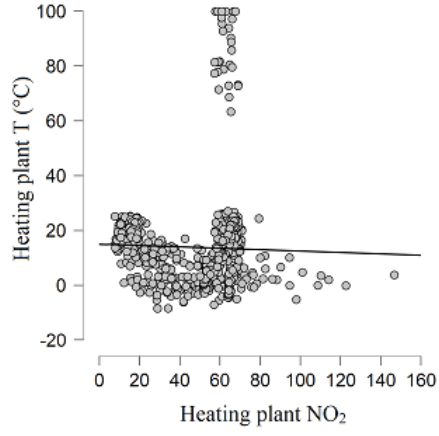

Figure 14. Correlation between NO_2 concentrations and temperature in location Heating plant

The positive correlation of NO_2 concentrations with the wind speed is significant in both localities Center (r = 0.565) Heating plant (r = 0.455) (Table 2). The wind speed increase is followed by rises of the NO_2 concentration values and vice versa.

There are very significant deviations regarding the correlation analysis at the location of the Heating plant concerning the location Center. The reason may be the existence of different dominant sources of pollution at the sites in question. At the Center location, traffic is the predominant source of pollution,

while at the Heating plant location, the most important source of pollution is coal combustion in the Heating plant.

CONCLUSION

This paper presents results of simultaneous measurement of SO_2, NO_2 and meteorological parameters at locality "Center" and "Heating plant" in the City of Bijeljina.

The mean annual value for two-year sampling periods for SO_2 in a research field is 19.39 μg/m^3 (locality Center) and 25.06 μg/m^3 (locality Heating plant). The results obtained for SO_2 were below regulatory limits. Measured average values of NO_2 at measuring points in Bijeljina are average values are 45.04 μg/m^3 (locality Center) and 55.62 μg/m^3 (locality Heating plant).

Dominant sources of pollution are traffic and coal combustion in the heating plant, which is especially noticeable in the winter when there is a significant increase in the concentrations of SO_2. Statistical analysis confirms directional connection between SO_2 and NO_2 and meteorological parameters, specially temperature in locality Center (r = - 0.639), wind speed in locality Heating plant (r = 0.399) and relative humidity (r = 0.162). The correlation of NO_2 with temperature was not confirmed in both localities. Speed of wind increase is followed by rises of the NO_2 concentration values and vice versa. Correlation NO_2 with pressure is confirmed in locality Center (r = 0.128) and not confirmed in the locality Heating plant. Correlation between NO_2 and relative humidity was found to be negative in locality Center (r = - 0.062). These parameters are the most important meteorological factors influencing the variation in SO_2 and NO_2 levels during the research. Depending on the obtained correlation, meteorological parameters had a positive or negative impact on air pollution.

REFERENCES

Abbasi, S., Jansson, A., Sellgren, U., & Olofsson, U. (2013). Particle emissions from rail traffic: A literature review. *Critical reviews in environmental science and technology*, *43* (23), 2511-2544.

Barbosa, P., Camia, A., Kucera, J., Liberta, G., Palumbo, I., San-Miguel-Ayanz, J., & Schmuck, G. (2008). Assessment of forest fire impacts and emissions in the European Union based on the European Forest Fire Information System. *Developments in Environmental Science*, *8*, 197-208.

BAS EN 14211 (2013). Ambient air - Standard method for the measurement of the concentration of nitrogen dioxide and nitrogen monoxide by chemiluminescence

BAS EN 14212 (2013) Ambient air - Standard method for the measurement of the concentration of sulfur dioxide by ultraviolet fluorescence

Cardu, M., & Baica, M. (2005). Regarding the relation between the NOx content and CO content in thermo power plants flue gases. *Energy conversion and management*, *46* (1), 47-59.

Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe [Internet]. Off. J. Eur. Union. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0050&from=en

Dueñas, C., Fernández, M. C., Cañete, S., Carretero, J., & Liger, E. (2002). Assessment of ozone variations and meteorological effects in an urban area in the Mediterranean Coast. *Science of the Total Environment*, *299* (1-3), 97-113.

Đuković, J., Bojanić, V. (2000). Air pollution - idea, condition, sources, control and technological solutions. Institute of Protection and Ecology, Banja Luka.

Erić, Lj., Tepić, S., Ilić, P., Račić-Milišić, S., Tubin, B. (2008). Presence of NO_2 and NO_X at the Center site in Banja Luka. 5th Symposium "Chemistry and Environmental Protection" with international participation. Tara, Serbian Chemical Society. Beograd.

Fino, A. (2019). Air Quality Legislation, Encyclopedia of Environmental Health (Second Edition), 61-70.

Ge, S., Xu, X., Chow, J. C., Watson, J., Sheng, Q., Liu, W., ... & Zhang, J. (2004). Emissions of air pollutants from household stoves: honeycomb coal versus coal cake. *Environmental science & technology*, *38* (17), 4612-4618.

Gong J, Hu Y, Liu M, et al. (2015). Characterization of Air Pollution Index and its affecting factors in industrial urban areas in Northeastern China. *Pol. J. Environ. Stud.* 24 (4), 1579–1592.

Grennfelt, P., Engleryd, A., Forsius, M., Hov, Ø., Rodhe, H., & Cowling, E. (2020). Acid rain and air pollution: 50 years of progress in environmental science and policy. *Ambio*, *49* (4), 849-864.

Hesterberg, T. W., Bunn III, W. B., Chase, G. R., Valberg, P. A., Slavin, T. J., Lapin, C. A., & Hart, G. A. (2006). A critical assessment of studies on the carcinogenic potential of diesel exhaust. *Critical reviews in toxicology*, *36* (9), 727-776.

Ilić, P. & Maksimović, T. (2021). Air pollution and biodiversity. Pan-European University Apeiron, Banja Luka.

Ilić, P. (2009). Quality control and research of air pollution influence in function of protection and environmental improvement in Banja Luka. Doctoral dissertation, ACIMSI, University of Novi Sad.

Ilić, P. (2015). Pollution and control of air quality in the function of environment protection. Independent University, Banja Luka

Ilić, P., Janjuš, Z. (2008). Air quality assessment regarding the presence of SO_2. *Scientific-professional Conference with international participation "Modern technologies for cities' sustainable development", Banja Luka, 14-15. November 2008, Institute for Protection and Ecology, Banja Luka*, 281-290.

Ilić, P., Lakić., N., Tubin, B., Janjuš, Z. (2008). Monitoring of sulfur dioxide at locality center in Banja Luka. *Second international congress ''Ecology, health, work, sport", Banja Luka.*

Ilić, P., Markić, D. N., & Bjelić, L. S. (2018). Variation concentration of sulfur dioxide and correlation with meteorological parameters. *Archives for Technical Sciences*, 18 (1), 81-88

Ilić, P., Marković, S., Janjuš, Z. (2009). Air pollution and its influence on ecosystems and vegetation. Conference: International Conference Evaluation and preservation potential of the Danube region, Banja Luka, Republic of Srpska, Bosnia and Herzegovina, 168-182.

Ilić, P., Popović, Z., Gotovac-Atlagić, S. (2019). Effects of meteorological variables on nitrogen dioxide variation. *Archives for Technical Sciences*, *20* (1), 65-72.

Ilić, P., Preradović, Lj. (2009). Simulation of pollution, i.e. modelling levels of nitrogen dioxide and meteorological parameters. *grkg/Humankybernetik*, 50 (3), 146-150.

Ilić, P., Preradović, Lj., Dejanović, R., Marković, S., Janjuš, Z. (2010). Using the factor analysis in monitoring of air pollution and meteorological parameters, Conference: 54th ETRAN Conference, Donji Milanovac, RT5.5-1-4

Jablanović, M., Jakšić, P., Kosanović, K. (2003). Introduction to ecotoxicology. University of Priština, Faculty of Science, Kosovska Mitrovica.

JASP Manual [Internet]; Seton Hall University Department of Psychology; c2021. [cited 12. September 2021]. Available from: https://www.shu.edu/psychology/upload/JASP-Manual_SHU-RD-A_9-1-18.pdf.

Jayamurugan, R., Kumaravel, B., Palanivelraja, S., & Chockalingam, M. P. (2013). Influence of temperature, relative humidity and seasonal variability on ambient air quality in a coastal urban area. *International Journal of Atmospheric Sciences*, *2013*.

Liu, Y., Zhou, Y., & Lu, J. (2020). Exploring the relationship between air pollution and meteorological conditions in China under environmental governance. *Scientific reports*, *10* (1), 1-11.

Maduna, K., & Tomašić, V. (2018). 7. Air pollution engineering. *Environmental Engineering*, 195-240.

Manisalidis, I., Stavropoulou, E., Stavropoulos, A., & Bezirtzoglou, E. (2020). Environmental and health impacts of air pollution: a review. *Frontiers in public health*, *8*, 14.

Mueller, D., Uibel, S., Takemura, M., Klingelhoefer, D., & Groneberg, D. A. (2011). Ships, ports and particulate air pollution-an analysis of recent studies. *Journal of Occupational Medicine and Toxicology*, *6* (1), 1-6.

Pandey, B., Agrawal, M., & Singh, S. (2014). Assessment of air pollution around coal mining area: emphasizing on spatial distributions, seasonal variations and heavy metals, using cluster and principal component analysis. *Atmospheric pollution research*, *5* (1), 79-86.

Prato, D. F., & Huertas, J. I. (2019). Determination of the area affected by agricultural burning. *Atmosphere*, *10* (6), 312.

Preradović, Lj., Ilić, P., Marković, S., Janjuš, Z. (2010). Functional dependences between air pollution and nitrogen dioxide-possibility of data mining application, Conference: 54th ETRAN Conference, Budva, Montenegro, VI2.3-1-4

Procurement plan for 2019, number 125/19, PE "City Heating Plant" d.o.o., City of Bijeljina, January 28, 2019.

Ramanathan, V., & Feng, Y. (2009). Air pollution, greenhouse gases and climate change: Global and regional perspectives. *Atmospheric environment*, *43* (1), 37-50.

Regulation on air quality values [Internet]; "Official Gazette of the Republic of Srpska", No. 124/12; c2012. [cited 11. September 2021]. Available from: https://rzsm.org/tehprop/151-mpuge

RoTAP (2012). Review of Transboundary Air Pollution: Acidification, Eutrophication, Ground Level Ozone and Heavy Metals in the UK*: Summary for Policy Makers*. Centre for Ecology & Hydrology.

Rulebook on measures for prevention and reduction of air pollution and improvement of air quality (Official Gazette of the Republic of Srpska, No. 3/15, 51/15, 47/16 and 16/19)

Stanek, L. W., Brown, J. S. (2019). Air Pollution: Sources, Regulation, and Health Effects. Reference Module in Biomedical Sciences., 1-10.

Thomas, M. D., & St. John, G. A. (1958). Nitric Oxide and Nitrogen Dioxide Concentrations Near the Ground at Menlo Park, California. *Journal of the Air Pollution Control Association*, *8*(3), 234-277.

Vasiliauskienė V, Šerevičienė V, Zigmontienė A. (2016). Spatial and Temporal Variation in Ozone and Nitrogen Dioxide in the Seaside Recreation Area Environment. *Pol. J. Environ. Stud.*, 25 (2), 795–803.

Von Glasow, R., Bobrowski, N., & Kern, C. (2009). The effects of volcanic eruptions on atmospheric chemistry. *Chemical Geology*, *263* (1-4), 131-142.

Warmiński, K., & Bęś, A. (2018). Atmospheric factors affecting a decrease in the night-time concentrations of tropospheric ozone in a low-polluted urban area. *Water, Air, & Soil Pollution*, *229* (11), 1-13.

Wessa, P. (2021), Free Statistics Software, Office for Research Development and Education, version 1.2.1, URL https://www.wessa.net/

Work plan for 2017 PE "City Heating Plant", d.o.o. Bijeljina, City of Bijeljina, March 2017.

www.who.int/health-topics/air-pollution#tab=tab_1

www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health

www.who.int/phe/eNews_63.pdf

Yadav, I. C., Devi, N. L. (2019). Biomass Burning, Regional Air Quality, and Climate Change, Encyclopedia of Environmental Health (Second Edition), 386-391.

Zhang, H., Wang, Y., Hu, J., Ying, Q., & Hu, X. M. (2015). Relationships between meteorological parameters and criteria air pollutants in three megacities in China. *Environmental research*, *140*, 242-254. Gvozdić, V., Kovač-Andrić, E., & Brana, J. (2011). Influence of meteorological factors NO_2, SO_2, CO and PM10 on the concentration of O 3 in the urban atmosphere of Eastern Croatia. *Environmental modeling & assessment*, *16* (5), 491-501.

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Professional paper

Management, Communication in the Health Institution

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ABSTRACT: If we look around, we can easily notice that the world would not function without communication. How could we express our thoughts and what we want unless we say it, show it and touch it? Therefore, the business world could not function without interpersonal communication either, especially in the health institutions.

The beginning of the research was based on the hypothesis that communication had to be open for the system to function, and employees satisfied with the working atmosphere and the relationship with the facility management. It was assumed that verbal communication was the most common form of communication, which often resulted in conflicts among health professionals. The research showed that the respondents were aware of the importance of creating effective communication, both within the same health care facility and outside it, especially conversation, assuming that they can convey the most important information in the shortest possible time. The data on formal communication at workplace indicated that employees believe that communication with their colleagues did not have to be formal, because in that way collective work would be more productive and the working atmosphere more pleasant. It is very important for every health care institution to invest enough funds in the activities, such as the health service promotion. Teamwork, health managers and employees contributed to the development of the health institution.

Key words: health management, health manager, communication, promotion.

INTRODUCTION

Communication represents an essential and very important human need and it refers to the process of conveying a message, processing its content and receiving it. Dress code or uniform is also a form of communication and indicates the seriousness of the work such as a health profession (Dobrijevic, 2011).

Managers can play a formal and informal role in health management. The formal role is played by the chief medical technician in an organization or a hospital. An informal role refers to the case when nurses / technicians gather and participate in seminars or professional meetings. They deal with planning, organization, coordination and work control, they stimulate and motivate subordinates and try to use the available resources as effectively as possible (Rakić, S., Antonić, D, 2015).

Health promotion and disease prevention programs focus on keeping people healthy and every health facility aims to engage and empower individuals and communities to choose healthy habits, and make changes that reduce the risk of developing chronic diseases and other morbidities. Promotional strategy is closely related to the communication process. It is important that the message is customized in terms of content, because otherwise it will not reach the desired effect. The reputation or image of a healthcare facility refers to its overall picture, or the opinion, prejudices, attitudes, experience of individuals or the public with the healthcare facility (Williams, 2010). The main strategy in promoting a market presence and gaining public and target groups trust is to create a healthy corporate image. The success of the facility will further depend on the image itself ((Lamb, C. W., Hair, JR, J.F., McDaniel C., 2017).

The research aimed to determine: the method and type of communication in the health care facility, employees' satisfaction with horizontal and vertical communication, acquirement of new knowledge in the field of health management and the importance of open communication, regardless the possible conflicts of interest.

MATERIALS AND METHODS

The research was conducted through a survey in paper form, with twenty-one questions and at least two or more offered answers. Theoretical framework which was used to form questions was about communication methods, health managers and management and promotional activities in health care. The research was anonymous because it was conducted for the purpose of a master thesis. It was implemented at the Primary Health Care Center in Bijeljina. Participation was voluntary and a large number of employees agreed to participate in the survey, even 98 of them, from various clinics and services, which was enough for this research. The research that was conducted among the employees of this health care facility was very important, because it was an indicator of their mutual functioning in their working environment. Respondents, who were included, were health professionals, different profiles of doctors and medical technicians, and no one was excluded. In order to get a realistic picture, related to this topic, all participants in the survey were equal, regardless of age, level of education and work experience (table 1, 2, 3). The response rate was satisfying; all of them answered all of the questions. It was conduced in August, 2021. The results of the survey were processed in MS Office, presented in charts and tables, and textually explained.

RESEARCH RESULTS

The largest number of respondents was exactly the target group that should be influenced. 46.9% of respondents were under 30 years old, 34.7% between 30 and 40 years old. 16.3% were 40 to 50 years old, 2.1% were over 50 years old.

Table 1. Data indicating the number of women and men in the survey

Respondents' gender	N	%
Male	15	15,3%
Female	83	84,7%
Total	98	100%

In the chosen healthcare facility, the majority of employees had secondary education suitable for the profession they performed. As the questionnaire was conducted on staff regardless the part of the institution they were employed in, out of the total number of respondents, 76 finished high school for medical professions (77.5%), 16 were holding university degree (16.3%), while 6 respondents were with postsecondary education degree (6.1%).

Table 2. Data indicating a work experience in a health care institution

Length of service	N	%
Up to 10	51	52,1%
10-20	28	28,6%
20-30	17	17,3%
Over 30	2	2,0 %
Total	98	100%

Table 3. The respondents' opinion on an importance of communication in a health care institution

Do you think that good communication between employees is one of the most important segments of work in health care?	N	%
Yes	79	80,6%
No	3	3,1%
Other elements	16	16,3%
Total	98	100%

Table 4. The review of respondents' knowledge of health managers duties and responsibilities

Do you know the levels of health care management and what are the duties and responsibilities of health managers?	N	%
No	5	5,0%
Yes	81	82,6%
Partially	12	12,4%
Total	98	100%

Table 5. The review of respondents' experience as healthcare managers or leaders

Have you ever been a health care manager or a leader?	N	%
Yes	16	16,33%
No, nor do I want to	25	25,5%
No, but I would like to	57	58,17%
Total	98	100%

The largest percentage of respondents expressed belief that health care managers of their health care facility invested effort and showed a desire for institution success, and this was indicated by the results that 80 (81.6%) answered negatively, 2 (2.1%) answered positively, and 16 of them (16.3%) did not express their opinion on this issue.

Table 6. The review of the respondents' promotional activities on work or outside

Do you promote the health care facility and its services through health and educational work or in other ways outside your workplace?	N	%
Yes, often	77	78,6%
Rarely	14	14,3%
No	7	7,1%
Total	98	100%

Table 7. The review of the respondents' opinion on communication with their superiors

Do you have open communication with your superiors or a certain fear to point out a problem?	N	%
Completely open communication	49	50,0%
Partially open communication	37	37,75%
Fear of expressing opinion	2	2,1%
Communication based on issuing work orders	10	10,2%
Total	98	100%

Table 8. The review of the respondents' opinion on a facility image

Does the health care facility image depend more on the management or employees?	N	%
Management	18	18,4%
Both	63	64,3%
Employees	17	17,3%
Total	98	100%

Table 9. The review of the respondents' opinion on a health care service promotion

If is a health service often promoted in the media or in similar ways, do you consider it to be of good quality?	N	%
Yes	54	55,1%
No	24	24,5%
I don't know	20	20,4%
Total	98	100%

The obtained results indicated positive changes in the attitudes of health workers, raising the level of professional competence and awareness.

Table 10. The review of the respondents' opinion on communication with colleagues

Are you open to communicate with colleagues in other sectors / clinics or other health care facilities?	N	%
Yes	98	100%
No	0	0 %
Total	98	100%

71,4% of respondents answered that if there was a problem, the solution should certainly be sought through conversation or communication. 20.4% of respondents answered that if there was a problem, they would immediately contact their superiors. There was also a smaller, but no less important percentage, 8.2% of respondents who did not want to come into conflict, even though they thought they were right.

Table 11. The review of the most represented types of communication within this health care facility

What type of communication is the most represented in your healthcare facility?	N	%
Verbal-conversation	68	69,4%
Medical documentation	7	7,14%
Nonverbal-body language	4	4,1%
Use of technology, exp. Telephone call, e-mail	17	17,34%
Other ways	2	2,04%
Total	98	100%

Table 12. The review of the respondents' strictly professional communication with colleagues

Is communication with colleagues strictly professional?	N	%
No	93	94,9%
Yes	5	5,1%
Total	98	100%

DISCUSSION

Communication is a fundamental clinical skill that, if performed competently and efficiently, provides trust between the medical staff and the patient or client, which makes them a real therapeutic alliance. The hypothesis that verbal communication was the most common type of communication with health managers was confirmed, but the other methods were also stated (table 11).

The respondents considered open communication as an obligation, because that was the only way to function, improve their work and create high-quality interpersonal relationships, which confirmed the main hypothesis of a survey. The employees wanted to feel comfortable at work, without feeling of discomfort, inconvenience and anxiety, and that was the reason why the work atmosphere was so important to them. This might have been concluded considering the fact that they talked to each other, helped each other and suggested a problem (table 12).

Previous research showed that employees considered the best managers to be those who actively listen and allow employees to participate. Conflicts were usual thing because it was normal that different people could have different opinion for the same thing, but more important thing was the fact that staff overcame them by conversation, with the help of managers or in other ways. Understanding how conflicts aroused was important in their prevention. From an employee's perspective, triggers included lack of communication, unfair criticism, silly rules, preferential treatment, sexism or racial inequality, humiliation, unreasonable expectations, and verbal abuse. From the management perspective, problems aroused from poor communication, inappropriate responses, poor prioritizing, personal work interfering with professional work, and clock-watching. However, teamwork was a priority in medicine and compromises were needed (Ramsay, 2001).

The study in the medical services domain noted that interactions between patients and health care professionals affected both patients' satisfaction and perceived quality of the medical services that they received, and that it could contribute to a better performance of the medical unit (table 9) (Interpersonal communication in healthcare, 2018).

It was proven, in the previous researches, that a healthcare management was an extensive job, which required the involvement of the entire health system, staff, finances and other factors. It was still important to invest in the health promotion and the development of healthy habits, disease prevention and early treatments and diagnoses, which was the main mission of every health institution (table 4 and 5).

When it came to taking credit for success, opinions were divided. Most of the respondents believed that for success and better image of the health care facility, the management and employees were equally important. Above mentioned data showed that the hypothesis that only health managers were responsible for the success and image of the health facility was refuted (table 8).

Health care managers could develop plans for a health care organization growth or formulate strategies to adjust to changes in the health care market. They should learn, train and practice more if they wanted to progress in terms of leadership or managerial functions. The interest in continuing education and high quality health care services promotion gave us information that our health care system was moving in a good direction. For example, the vaccination promotion (covid 19) was for the purpose of collective health protection, and not to make a profit. The absolute willingness to cooperate with colleagues from the other sectors and health care institutions could provide the progress of the whole health care system in our country (table 10) (Dragic M. , 2017).

Some products or health care services, despite their good quality, could be neglected, because there was a lack of promotion and that should be changed. The main reason for this was probably an insufficient service improvement activity or an inadequate approach to marketing. That could affect health managers who should invole health care professionals in the whole business process and progress in health care, because of their qualifications, skills, organizational and other abilities and their contribution to the team and the institution. It was for sure that there work some creative people who were ready to take a risk and express useful ideas (table 11).

The common occurance in every health care institution regardless the region was high percentage of cooperation with colleagues, which required the use of medical and nursing documentation as a source of a large amount of useful information and tendency to create comfortable working conditions without unnecessary stress. A lot of pressure, little time and a lot of work could affect healthcare workers to reduce communication with patients or colleagues. Empathy was also very important, because the target population was very sensitive due to the specific condition (illness, hospitalization, etc) (Segic, 2011).

CONCLUSION

The main hypothesis was confirmed that a pleasant working atmosphere with effective organizational communication is the key in achieving the common goals of the organization. There was a need to emphasize more promotional activities online and in other ways. Based on the survey, we also gained insight into the staff education on health management, their experience as leaders in health care (if they had it), the employee relations and their relation with healthcare managers. It was important that healthcare professionals make effort to overcome conflicts and therefore give importance to effective communication. It was also possible to organize online discussion groups so that managers and workers could work together to solve problems. It was important to encourage the use of horizontal communication, because more experienced colleague could help a younger colleague at work. Fast-growing companies, for example, sought to inform employees about what happened in the company, but they designed and determined the image for the outside world. Today, the health care centeres strove to inform employees about what happened there and motivated them to take part in the progress of the institution.

LITERATURE:

Dobrijevic, G. (2011). Poslovno komuniciranje i pregovaranje, Beograd.

Dragic, M. (2017). Menadžment u zdravstvu, skripra, četvrto izdanje, Visoka medicinska škola Prijedor, 2017.

Lamb, C. W., Hair, JR, J.F., McDaniel C. (2017). Marketing MKTG. Second edition. Data status. Belgrade, p. 286.

Lukić, S., Lukić, S. (2012). Kadrovski menadžment, Menadžment ljudskih resursa, Panevropski Univerzitet "Apeiron" Banjaluka.

Rakić, S., Antonić, D. (2015) Osnove zdravstvenog menadžmenta, Panevropski Univerzitet "Apeiron", Banjaluka.

Segic, S. (2011). Marketing psihologija, Panevropski Univerzitet "Apeiron" Banjaluka.

Williams, C. (2010). Principles of management, Status of data. Belgrade. p. 282-284.

Journal of medicine and life (2018) Apr-Jun; 11(2): 119–122

Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6101690/ Accessed: 15.12.2021

Athenc State University (2021). Helthcare administration vs. helthcare management. Available from: https://online.athens.edu/blog/healthcare-administration-vs-healthcare-management/ Accessed: 16.12.2021

Ramsay, M. (2001). Conflict in the health care workplace. Baylor University Medical Center Proceedings, Dallas, Texas. Apr; 14(2): 138–139.

Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1291328/ Accessed:14.12.2021

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Review Article

Plant Volatile Oils and Compounds as Ecofriendly Mosquito Control Products: Review on Recent Developments

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ABSTRACT: Mosquitoes occupy the first place among the most dangerous insects in the world, because they kill more than five lakhs people every year around the world by transmitting lethal pathogens. People use many methods and devices to combat the mosquito problem. Chemical pesticides are commonly used to control mosquitoes and their bites around the world. Since the last two decades public has started to avoid the use of synthetic chemicals for mosquito management due to their harmful effects on environment and human health. Pesticide resistance in mosquitoes is a major side effect of synthetic chemical applications. Volatile oils or essential oils obtained from green plants are considered as reliable alternatives for mosquito management. Several hundred volatile oils and volatile compounds have been tested against eggs, larva, pupa and adults of various vector mosquito species. Oils, extracts and powders of leaf, flowers and bark of many aromatic plants are being used as mosquito repellents in many countries for many centuries. Scientific validation of biological activities of several botanicals has been intensified in the last three decades and several herbal mosquito control products have been commercialized. The aim of the present review article is to provide up-to-date information on biological activities of plant volatile oils and volatile compounds against vector mosquitoes and to highlight the promising volatile compounds for the development of new herbal mosquito control products.

Keywords: volatile oils, 1,8- cineole, thymol, larvicides, repellents, mosquitoes.

INTRODUCTION

Mosquitoes are major public health pests throughout the world. They are distributed all over the world, except Antarctica. World mosquito fauna comprises 3541 species grouped under 112 genera (Tyagi et al., 2015); more than a hundred species of mosquitoes are capable of transmitting various diseases to humans and other vertebrates. Female mosquitoes transmit many pathogenic organisms and cause diseases such as malaria, West Nile virus (WN), dengue, filariasis, yellow fever, Japanese encephalitis and Chikungunya among humans. Mosquito bites also cause considerable pain and loss of sleep; weight loss and decreased milk production in farm animals have been reported due to mosquito bites (Nour et al., 2009).

At present several synthetic insecticides and growth regulators namely methoprene, pyriproxyfen and diflubenzuron and microbial products from *Bacillus thuringiensis israelensis* and *B. sphaericus* are used in mosquito control programmes (Shaalan et al., 2005; Ben-Dov, 2014; Lacey et al., 2015). Pyrethroids and malathion are recommended as adulticides and temephos (an organophosphate insecticide better known as Abate®), petroleum oils, S-methoprene (Insect growth regulator), *Bacillus thuringiensis israelensis* and *B. sphaericus* are recommended as mosquito larvicides (Brattsten et al., 2009). Vector mosquitoes have developed resistance against many synthetic pesticides due to injudicious use of pesticides and in fact this is the major reason for the resurgence of many mosquito-borne diseases (Becker et al., 2003). Since 1947 more than 100 mosquito species have been reported as resistant to one or more insecticides (Hemingway and Ranson, 2000; Hemingway *et al.*, 2002).

Prevention of mosquito bite is the most common approach among the public. Personal protection by means of avoidance techniques such as using physical and chemical barriers, treatment of fabric with toxicants and the use of topical (skin) repellents is the commonly advocated approach for preventing mosquito bite (Barnard and Xue, 2004).

Plant products are considered as ecofriendly insecticides and are potential alternatives to synthetic insecticides. Pyrethrum, derris, quassia, nicotine, hellebore, anabasine, azadirachtin, d-limonene camphor and turpentine were widely used as alternate insecticides in developed countries before the introduction of synthetic organic insecticides (Wood, 2003). Plant essential oils are ecofriendly 'green pesticides' and safe to mammals and environment (Mossa, 2016). Essential oils are complex mixtures of compounds mainly of monoterpenes and sesquiterpenes. Several scientific studies have disclosed the efficacy of plant volatile oils and volatile compounds in pest and vector management (Mondal and Khalequzzaman, 2006; Paulraj and Ignacimuthu, 2007; Pavunraj et al., 2007; Sivanandhan et al., 2021). Many volatile oils have larvicidal, pupicidal and oviposition deterrent effects against vector mosquitoes (Chantawee and Soonwera, 2018)

The present review article highlights the promising volatile oils and plant volatile compounds which show significant larvicidal and repellent activities against common vector mosquitoes.

LARVICIDAL ACTIVITY OF VOLATILE OILS AND VOLATILE PLANT COMPOUNDS

Mosquito control programmes are largely targeting the larval stage in their breeding sites with larvicides (El Hag et al., 1999 & 2001). Larviciding is a successful method of reducing mosquito population in their breeding places before they emerge into adults (Tiwary et al., 2007). Application of synthetic larvicides in aquatic ecosystems may cause harmful effects on human beings and many other non-target organisms. In search of alternative pesticides many investigators have explored the beneficial role of plant extracts, plant compounds, actinomycetes sea weeds and mushroom extracts against mosquito larvae (Campbell and Sullivan, 1993; Thangam and Kathiresan, 1994; Pandey et al., 2007; Nazar et al., 2009; Ganesan et al., 2018; Darvin et al., 2019; Sivanandhan et al., 2019; Monisha et al. 2020). Many essential oils showed good larvicidal activities against mosquito species and are reported as environmentally safe insecticides (Corbet et al., 1995; Pitasawat et al., 2007). Some effective essential oils as larvicides against different mosquito species are given in Table 1.

Table 1. Some effective volatile oils and their major components reported for mosquito larvicidal activity

Essential oil source	Target species	Effective concentration or LC_{50}	Major components in the oil	Reference
Boswellia serrata	*Culex pipiens*	83.36 ppm	NS	Khater and Shalaby (2007)
Brassica compestris		71.37 ppm		
Calocedrus formosana Florin Bark	*Aedes aegypti*	51.8 mg/ml	NS	Cheng et al. (2003)
C. formosana Florin leaf		56.3 mg/ml	NS	
Carum ptroselinum	*Cx. pipiens*	152.94 ppm	NS	Khater and Shalaby (2007)
Chenopodium ambrosioides (aerial parts)	*Anopheles arabiensis*	17.5 ppm		Massebo et al. (2009)
	A. aegypti	9.1 ppm		
Cinnamomum camphora leaves	*Anopheles stephensi*	LC50 = 0.026% LC95 = 0.128% at 24 h	Eucalyptol (53.49%) B-terpinene (17.44%) α-terpineol (9.45%)	Xu et al. (2020)

Citrus aurantium subsp. *Bergamia* fruit rind (cold pressed)	*Cx. pipiens*	58.73 mg/L (48 h)	Linalyl acetate	Eleni et al. (2009)
C. aurantium subsp. *Bergamia* fruit rind (hydrodistillation)		106.6 mg/L (48 h)	Linalool and Limonene	
C. aurantium subsp. *Bergamia* Leaves		68.53 mg/L (48 h)	Linalyl acetate and Limonene	
Corymbia citrodora leaves	*An. arabiensis*	40.3 ppm		Massebo et al. (2009)
	Ae. aegypti	38.7 ppm		
Cryptomeria japonica	*Ae. aegypti*	48.1 mg/ml	NS	Cheng et al. (2003)
C. japonica leaf		37.6 mg/ml	NS	
Curcuma aromatica	*Ae. aegypti*	36.3 ppm		Choochote et al. (2005)
Cymbopogon citrates Stapf.	*Ae. aegypti*	69 ppm (24 h)	geranial (60.3%) and neral (39.7%).	Cavalcanti et al. (2004)
C. nardus (L.) Rendle (2nd Fraction)	*Cx. quinquefasciatus*	1.7 mg/l (1.4 mg/l after 3 months of storage at 29°C)	Myrcene	Ranaweera and Dayananda (1996)
Cymbopogon winterianus (Citronella oil)	*Ae. aegypti*	LC50= 111.84 µg mL^{-1}	NS	Cansian et al. (2021)
Cyperus esculentus	*Cx. pipiens*	47.17 ppm	NS	Khater and Shalaby (2007)
Dendropanax morbifera flowers	*Ae. aegypti*	62.32 ppm	γ-elemene (18.59%), tetramethyltricyclohydrocarbon (10.82%), β-selinene (10.41%), α-zingibirene (10.52%), 2-isopropyl-5-methylbicylodecen (4.2%), β-cubebene (4.19), and 2,6-bis(1,1-Dimethylethyl)-4-phenol (4.01%).	Chung et al. (2009)
Eruca sativa	*Cx. pipiens*	86.06 ppm	NS	Khater and Shalaby (2007)
Eucalyptus montana leaves	*An. arabiensis*	68.3 ppm		Massebo et al. (2009)
	Ae. aegypti	52.9 ppm		
Ipomoea cairica Linn.	*Cx. tritaeniorhynchus*	14.8 ppm	-	Thomas et al. (2004)
	Ae. aegypti	22.3 ppm		
	An. stephensi	14.9 ppm		
	Cx. quinquefasciatus	58.9 ppm		
Lavandula angustifolia	*Cx. pipiens*	LC50 = 140µg/ml LC=90=450µg/ml	Linalool (32.23%) Linalyl acetate (14.23%)	El-Akhal et al. (2021)
Lavandula dentata		LC50=2670 µg/ml LC90=7400 µg/ml	1,8-Cineole (49.82%) Camphor (6.31%)	
Lippia adoensis leaves	*An. arabiensis*	56.4 ppm		Massebo et al. (2009)
	A. aegypti	47.1 ppm		
L. sidoides	*Ae. aegypti*		Thymol	Carvalho et al. (2003)
L. sidoides	*Ae. aegypti*	63 ppm (24 h)	Thymol (80.8%); p-Cymene (8.6%); Trans-Caryophyllene (5.1%)	Cavalcanti et al. (2004)
Mentha spicata leaves	*An. arabiensis*	85.9 ppm	NS	Massebo et al. (2009)
	Ae. aegypti	67.8 ppm		
Nigella sativa leaves	*An. arabiensis*	23.4 ppm	NS	
	Ae. aegypti	32.1 ppm		

Ocimum americanum L.	*Ae. aegypti*	67 ppm (24 h)	E-Methyl-Cinnamate (70.9%); Z-Methyl-Cinnamate (8.8); Trans-Bergamoptene (6.8%); Trans-Caryophyllene (4.6%)	Cavalcanti et al. (2004)
O. basilicum L (four accessions)	*Anopheles* sp.	190 µL/L to 300 µL/L	eugenol, geraniol and linalool	Nour et al. (2009)
O. gratissimum L.	*Ae. aegypti*	60 ppm (24 h)	Eugenol (43.7%); 1,8-cineole (32.7%); Z-Ocimene (6.2%); Trans-Caryophyllene (4.1%)	Cavalcanti et al. (2004)
O. lamiifolium leaves	*An. arabiensis*	20.9 ppm		Massebo et al. (2009)
	Ae. aegypti	8.6 ppm		
O. suave leaves	*An. arabiensis*	53.5 ppm		Massebo et al. (2009)
	Ae. aegypti	29.8 ppm		
Pinus longifolia (pine oil)	*An. stephensi*	112.6 ppm	K–terpineole (12.89%); Isoeugenol (4.93%); Eugenol (3.14%); Caryophyllene (2.94%)	Ansari et al. (2005)
	Ae. aegypti	82.1 ppm		
	Cx. quinquefasciatus	85.7 ppm		
P. gaudichaudianum	*Ae. aegypti*	121 µg/ml	Viridiflorol (27.5%), Aromadendrene (15.55 %), β-Selinene (10.5%), Ishwarane (10%)	Morais et al. (2007)
P. hostmanianum		54 µg/ml	Asaricin (27.37%), Myristicin (20.26%), Dillapiol (7.66%), Germacrene D (6.82%), Piperitone (5.58%)	
P. humaytanum		156 µg/ml	Caryophyllene oxide (16.63%), β-Selinene (15.77%), Spathulenol (6.33%), b-Oplopenone (6.02%), Sesquicineole (5.03%)	
Piper marginatum Jacq. (leaves)	*Ae. aegypti*	23.8 ppm	(Z)-Asarone (30.4%), Patchouli alcohol (16%), Elemol (9.7%), Bicyclogermacrene (9.4%), (E)-Caryophyllene (7.5%), (E)-Asarone (6.4%)	Autran et al. (2009)
P. marginatum (stem)		19.9 ppm	(E)-Asarone (32.6%), Patchouli alcohol (25.7%), (Z)-Asarone (8.5%), Elemicin (6.9%), (E)-Caryophyllene (6.8%), Seychellene (5.8%), (E)-Methyl isoeugenol (3.6%)	
P. marginatum (inflorescence)		19.9 ppm	Patchouli alcohol (23.4%), (E)-Asarone (22.1%), (E)-Caryophyllene (13.1%), α-Acoradiene (9.7%), α-Copaene (9.4%), (Z)-Asarone (4.5%), δ-Elemene (3.1%)	
P. nigrum seeds	*An. arabiensis*	33.5 ppm	NS	Massebo et al. (2009)
	Ae. aegypti	9.1 ppm		
P. permucronatum	*Ae. aegypti*	36 µg/ml	Dillapiol (54.7%), Myristicin (25.61%), Elemicin (9.92%), Asaricin (8.55%)	Morais et al. (2007)

Satureja montana (stems, leaves and flowers)	*Cx. pipiens* biotype *molestus*	37.7 mg/L	Carvacrol (55.42%), γ-terpinene (13.24%), *p*-cymene (9.45%)	Michaelakis et al. (2007)
S. thymbra (stems and leaves)		44.5 mg/L	Thymol (42.15%), γ-terpinene (20.12%), *p*-cymene (10.39%)	
S. thymbra (stems, leaves and flowers)		64.4 mg/L	Carvacrol (30.39%), Thymol (24.32%), γ-terpinene (14.64%), *p*-cymene (9.19%)	
S. spinosa (stems and leaves)		56.1 mg/L	Carvacrol (47.12%), Thymol (12.39%), γ-terpinene (6.49%), *p*-cymene (5.48%), *β*-caryophyllene (4.98%), thymol, methyl ether (4.05%)	
S. parnassica ssp. *parnassica* (stems and leaves)		52.1 mg/L	Thymol (44.39%), γ-terpinene (12.32%), *p*-cymene (8.35%), Carvacrol (6.36%), *β*-caryophyllene (4.42%)	
Schinus molle leaves	*An. arabiensis*	21.0 ppm	NS	Massebo et al. (2009)
	Ae. aegypti	9.6 ppm		
S. molle seeds	*An. arabiensis*	26.5 ppm	NS	
	Ae. aegypti	14.5 ppm		
Thymus vulgaris leaves	*An. arabiensis*	33.7 ppm	NS	
	Ae. aegypti	17.3 ppm		
Thymus vulgaris	*Aedes aegypti*	---	Thymol	Maia et al. (2019)
Trigonella foenumgrecum	*Cx. pipiens*	32.42 ppm	NS	Khater and Shalaby (2007)
Zanthoxylum armatum DC seeds	*Cx. quinquefasciatus*	49 ppm	Linalool, Limonene, E-methyl cinnamate	Tiwary et al. (2007)
	Ae. aegypti	54 ppm		
	An. stephensi	58 ppm		
Zingiber cassumunar	*Ae. albopictus*	LC50=44.9 µg/L in 24 h	(-) terpinen-4-ol (1) (isolated by bioassay-guided isolation)	Li et al. (2021)
Ziziphora clinopodioides Lam.	*An. stephensi*	14.9 (µg/ml)	Pulegone, Piperitone, Menth-2-en-1-ol and carvacrol	Mohammadreza (2008)
	Cx. pipiens	16.5 (µg/ml)		

NS- Not Studied

Larvicidal activity of essential oils of nine Brazilian plants was studied against *Aedes aegypti*. *Ocimum americanum* and *O. gratissimum* oils recorded 100 per cent mortality at 100 ppm concentration and their effect was comparable to *Lippia sidoides* and *Cymbopogon citrates* (Cavalcanti et al., 2004). Plant volatile oils contain a range of bioactive compounds. Identification and confirmation of larvicidal components present in the active essential oils by separation techniques such as TLC and GC-MS is an essential part of work in the bioassay experiments. Nour et al. (2009) have documented the larvicidal activity of essential oils obtained from four Sudanese accessions of Basil (*Ocimum basilicum*) against *Anopheles* larvae. They found that accession no. 16 (introduced from UA Emirates) and 17 (introduced from Germany) were more effective with LC_{50} of 190 and 200 µL L^{-1} respectively. They reported that eugenol, geraniol and linalool were the major volatile components in the basil essential oils and these compounds caused 100 per

cent larval mortality within half an hour of exposure. Essential oil of *Tridax procumbens* leaves showed larvicidal activity against *Aedes aegypti* at LC_{50} concentration of 79.0 μg mL^{-1} and 69.15 μg mL^{-1} in 24 and 48 h, respectively. Thymol (48.22%), *γ*-Terpinene (15.93%), *o*-Cymene (10.27%) and Carvacrol methyl ether (7.7%) were detected as major compounds in *T. procumbens* essential oil by GC-MS analysis method (Brandão et al., 2021). Essential oils of 28 plant species were tested individually against *Cx. quinquefasciatus* larvae and adults and binary combinations of effective oils were again tested. Combination of *Allium sativum* (bulbs) and *Citrus paradisi* (leaves) oils at 1:1 volume ratio recorded the highest larvicidal activity and GC-MS analysis revealed the presence of diallyl disulfide, linalool, citronellal and caryophyllene oxide as major constituents (Mahanta and Khanikor, 2021).

It is generally concluded that the major component present in the volatile oil may be the actual cause of larval death. To confirm this, the individual compound of interest should be tested for its activity. Some studies have indicated that the volatile compounds thymol and carvacrol were responsible for larvicidal activity against mosquito larvae. Carvalho et al. (2003) studied the larvicidal activity of essential oil of *Lippia sidoides* and its major components thymol and carvacrol against *Ae. aegypti*. They reported that the pure essential oil and dilution of oil at 1: 2 ratio recorded 100 per cent larval mortality within 5 minutes and thymol recorded 100 per cent larval mortality at 0.04% within 30 min. Dilutions of oil at 1: 5 and 1: 10 ratios caused 100 per cent larval mortality within 20 minutes and after 24 h respectively. Carvacrol did not cause any larval mortality at 0.04% concentration. Cavalcanti et al. (2004) have also reported the larvicidal activity of *L. sidoides* oil against *Ae. aegypti*. Their study clearly indicated that 63 ppm of *L. sidoides* oil killed 50 per cent larvae in 24 h and they reported that the oil contained thymol (80.8%) as the major component. Besides *L. sidoides* oil Cavalcanti et al. (2004) screened eight more essential oils from Brazilian plants against *Ae. Aegypti* larvae. They found that the essential oils of *Ocimum americanum*, *O. gratissimun* and *C. citratus* were as potent as *L. sidoides* and caused 100 per cent mortality at a concentration of 100 ppm. Michaelakis *et al*. (2007) analysed the essential oils of *Satureja montana* and *S. thymbra*, which showed high toxicity against the larvae of *Culex pipiens* biotype *molestus* and found that carvacrol or thymol were the major components. According to them the larvicidal activity was a result of the synergistic effect of the phenolic compounds with other components that were present in the oils tested. In a study essential oils were extracted from leaves of 10 *Piper* spp. and larvicidal activity was studied against strains of Pyrethroid resistant and susceptible *Ae. Aegypti.* Among the ten species, five species viz., *Piper aduncum, P. marginatum, P. gaudichaudianum, P. crassinervium*, and *P. arboretum* were found to be active since they recorded larvicidal activity between 90–100% at 100 ppm concentration. The active compounds in the oils namely *(E)*-Anethole, β-Asarone, γ-Terpinene, *p*-Cymene, Limonene, α-Pinene, β-Pinene and Dillapiole showed larvicidal activity between 90-100% at 100 ppm (Filho et al., 2021). Knio et al. (2008) studied the larvicidal activity of essential oils extracted from commonly used medical and culinary herbs in Lebanon against the fourth instar larvae of seaside mosquito *Ochlerotatus caspius*. They found that thyme inflorescence extract was the most potent larvicide followed by parsley seed oil, aniseed oil and coriander fruit oil. Based on GC-MS analysis they reported that thymol, sabinene, carvacrol, anethole and linalool were the major components of parsley seeds and leaves, alpine thyme inflorescences, anis seeds and coriander fruits respectively. These studies support the fact that thymol in volatile oils is a toxicant against mosquito larvae. (Cavalcanti et al., 2004; Cheng et al., 2004; Choochote et al., 2005; Knio et al., 2008; Maia et al., 2019)

Tiwary et al. (2007) studied the larvicidal activity of volatile oils obtained from the seeds of *Zanthoxylum armatum* against *Cx. quinquefasciatus*, *Ae. aegypti* and *An. stephensi*. They analysed the volatile oils by GC-MS and found that linalool (57%) and limonene (19.8%) were the major components. Linalool was reported as mosquito repellent by Omolo et al. (2004) and Traboulsi et al. (2005). At the same time

Traboulsi et al. (2002) and Cheng et al. (2004) discovered that linalool at higher doses caused larval mortality. The study by Chantraine et al. (1998) indicated that linalool did not cause larval mortality in *Ae. aegypti* at doses ranging between 10 and 100 ppm.

Kelm and Nair (1998) isolated two compounds from hexane extract of *Ocimum sanctum* leaves and stem and screened them against *Ae. aegyptii* larvae. They claimed that eugenol and (*E*)-6-hydroxy-4,6-dimethyl-3-heptene-2-one exerted larvicidal activity at 200 and 6.25 μg mL^{-1} concentrations respectively in 24 h.

Several investigators have reported that 1,8-cineole is mainly responsible for pesticidal properties against many insects (Duke, 2004). Lucia et al. (2007) studied the larvicidal activity of *Eucalyptus grandis* and pine resin essential oils (turpentine) and their major components namely α- and β-pinene and 1,8-cineole against third and fourth instar *Ae. aegypti* larvae. They recorded that turpentine oil was more active (LC_{50} of 14.7 ppm) than the essential oil of *E. grandis* (LC_{50}: 32.4 ppm), which contained 1,8-cineole. Klocke et al. (1987) found that 1,8-cineole, present in the volatile oil of *H. fitchii,* did not exhibit any significant mosquito larvicidal activity. But the oil acted as a moderate feeding repellent and highly effective ovipositional repellent against adult *Aedes aegypti.*

Chung et al. (2009) have reported that the essential oil obtained from *Dendropanax morbifera* flowers had a significant toxic effect against early fourth instar larvae of *Ae. aegypti* with an LC_{50} and LC_{90} of 62.32 and 131.21 ppm respectively and the oil contained 27 compounds; the major components were γ-elemene (18.59%), tetramethyl tricyclohydrocarbon (10.82%), β-selinene (10.41%), α-zingibirene (10.52%), 2-isopropyl-5-methylbicyclodecen (4.2%), β-cubebene (4.19%) and 2,6-bis (1,1-Dimethylethyl)-4-phenol (4.01%). The pure compound that was isolated from the essential oils gave higher larvicidal activity than crude essential oils. Tripathi et al. (2004) have reported that the compound piperitenone oxide that was isolated from oil of *Mentha spicata* variety *viridis* recorded higher larvicidal activity (LD_{50}=61.64 μg/ml) than the crude essential oil (LD_{50}=82.95 μg/ml) against *An. stephensi.*

Cheng et al. (2009) evaluated the larvicidal activity of leaf essential oils of six chemotypes of cinnamon (*Cinnamomum osmophloeum*) against *Ae. albopictus, Armigeres subalbatus* and *Cx. quinquefasciatus.* In their study the leaf essential oils of cinnamaldehyde type (LC_{50} =40.8 μg/ml; LC_{90} = 81.7 μg/ml) and cinnamaldehyde/cinnamyl acetate type (LC_{50}=46.5 μg/ml; LC_{90} = 83.3 μg/ml) recorded the maximum inhibitory effect against *Ae. albopictus* larvae. They also reported that the effective constituents in leaf essential oils were *trans*-cinnamaldehyde and benzaldehyde and the LC_{50} values of these constituents against *A. albopictus* larvae were below 50 μg/ml.

The larvicidal activity of essential oils varies between different mosquito species. Pitasawat et al. (2007) have reported that among the aromatic oils obtained from five different plant species, *Carum carvi*, *Apium graveolens*, *Foeniculum vulgare*, *Zanthoxylum limonella* and *Curcuma zedoaria, Z. limonella* oil was the most effective against *A. aegypti* with LC_{50} and LC_{95} values of 24.61 and 55.81 ppm, respectively and *C. zedoaria* oil was the most effective against *A. dirus* larvae (LC_{50} and LC_{95} values: 29.69 and 40.23 ppm, respectively). Eleven essential oils out of 12 obtained from plants namely *Chenopodium ambrosioides* (aerial parts), *Ocimum lamiifolium* (leaves), *O. suave* (leaves), *Schinus molle* (leaves and seeds), *Piper nigrum* (seeds), *Corymbia citriodora* (leaves), *Eucalyptus globules* (leaves), *Lippia adoensis* (leaves), *Mentha spicata* (leaves) and *Thymus vulgaris* (leaves) were evaluated. They showed higher larval toxicity in *Ae. Aegypti* than *An. arabiensis* after 24 h exposure and oil obtained from *Nigella sativa* (leaves) recorded higher toxicity against *An. arabiensis* (Massebo et al., 2009). In a review Shaalan et al. (2005) had stated that mosquito larvae of different species displayed different susceptibilities to the same phytochemical and *Aedes* larvae, in general, were robust and less susceptible to insecticides and botanicals than *Culex* larvae.

IMPROVING THE LARVICIDAL ACTIVITY OF VOLATILE OILS

Studies on the improvement of the larvicidal activity of volatile oils have been done by some investigators. Corbet et al. (1995) have studied the usefulness of some surfactants to increase the larvicidal activity of essential oils. In their study they used 1% insoluble surfactant (Arosurf MSF) and 1% detergent with eucalyptus and turpentine oils separately. They reported that refined turpentine at a dose of 2 µl per tub (=0.13 µl cm^{-2}) acted faster due to the addition of surfactants (turpentine: Arosurf: detergent 100:1:1 by volume) causing higher mortality in fourth instar *Cx. pipiens* form *molestus* at 24 and 48 h after treatment, than familiar surface-active larvicide Arosurf alone.

REPELLENT PROPERTY OF VOLATILE OILS

The relationship between man and blood sucking insects is very old and man has learnt adequate techniques to avoid the mosquito biting. Keeping away the adult mosquitoes from human habitats and preventing mosquito bites are vital tactics in personal protection from mosquito borne diseases. Repellents are the prime products used for the protection from mosquito bites. Due to the enormous developments in science and technology new insect repellents are being discovered. Synthetic repellents are the most commonly used materials against mosquitoes. DEET (N, N-diethyl-3-methylbenzamide) is the most commonly used synthetic mosquito repellent. Insect repellent property of DEET was first discovered in 1953 and the first DEET product was introduced in 1956 (Peterson and Coats, 2001). It is an effective insect repellent against a broad spectrum of insects including mosquitoes.

Injudicious use of synthetic skin repellents which contain DEET may affect human health (Qui et al., 1998; Eden et al., 2020). Some investigators have pointed out the allergic reactions and human toxicity of DEET (Robbins and Cherniack, 1986; Edwards and Johnson, 1987; Qui et al., 1998). Peterson and Coats (2001) have noted that encephalopathy in children, urticaria syndrome, anaphylaxis, hypotension and decreased heart rate are some toxic effects associated with DEET. Trigg (1996), Walker et al. (1996), Debboun et al. (2000), Peterson and Coats (2001), Fradin and Day (2002) and Badolo et al.(2004) have pointed out that DEET has the ability to act as a good solvent for plastics and other synthetic materials and search for alternative repellents including natural products are essential. Since DEET is a chemical, a concentration of less than 10 per cent is recommended for children.

The novel repellents are mainly based on human safety. Electronic mosquito repellent is said to be environmentally friendly. But these electronic devices have been shown to have no effect as a mosquito repellent (Andrade and Bueno, 2001). In many countries aromatic plants are playing important role in mosquito management since ancient times. Very early report on mosquito repellent properties of essential oils was made by Penfold and Morrison (1952). They have reported the repellent and insecticidal activities of forty Australian essential oils against vector insects including mosquitoes. They reported that the essential oils obtained from *Dacrydium franklini, Backhousia myrtifolia, Mela-leuca bracteata* and *Zieria smithii* were the most effective.

In African countries *Hyptis suaveolens, Ocimum* spp. and *Daniellia oliveri* are used as traditional repellents against mosquitoes (Curtis et al., 1991). Aromatic plants contain volatile oils and volatile compounds which are responsible for their mosquito repellent property. In table 2 the mean protection time or repellency time of some essential oils against different mosquito species is given. The essential oil of *Ocimum suave* contained eugenol and six terpenoid substances and was an effective mosquito repellent (Chogo and Crank, 1981). Literature on the repellent activity of volatile oils against different mosquito species is plenty (Yang and Ma, 2005; Gillij et al., 2008). Repellency of volatile oils extracted from six plant species

namely *Croton pseudopulchellus*, *Mkilua fragrans*. *Endostemon tereticaulis*, *Ocimum forskolei*, *O. fischeri* and *Plectranthus longipes* was evaluated against *An. gambiae sensu strict* (Odalo et al., 2005). Citronella and pennyroyal essential oils have been used as repellents against insects since ancient times (Jantan and Zaki, 1999).

Table 2. Repellent activity of some essential oils against vector mosquitoes

Volatile oil source	Target mosquito	Repellency/ Protection time	Effective concentration	Reference
Acantholippia seriphioides	*Aedes aegypti*	70 min	50 %	Gillij et al. (2008)
Aloysia citriodora		90 min	12.5 %	
Baccharis spartioides		90 min	12.5%	
Cinnamomum mollisimum	*Ae. aegypti*	100%	0.0379 mg cm^2	Jantan and Zaki (1999)
Citronella + vanillin	*Ae. aegypti, Anopheles dirus, Culex quinquefasciatus*	100% (6 h),	0.1 ml of 25% oil in 5% vanillin per 3x10 cm skin in the arm	Tawatsin et al. (2001)
Citrus limon Burm	*An. stephensi*		1%	Oshaghi et al. (2003)
C. citronella (lemon grass oil)	*An. culicifacies*	100 %	Pure oil (1 ml)	Ansari et al. (2005)
	Cx. quinquefasciatus	98.5%		
Cymbopogan martinii martinii Stapf var *sofia*	*An. sundaicus*	8 hrs (98.7%) (in indoor) and 6 hrs (96.52%) (in outdoor)	Pure oil (1ml)	Das and Ansari (2003)
Cymbopogan nardus	*Ae. aegypti*	72.2%	0.0047 mg cm^2	Jantan and Zaki (1999)
Eucalyptus saligna	*Ae. aegypti*	90 min	50 %	Gillij et al. (2008)
Litsea elliptica	*Ae. aegypti*	100%	0.0379 mg cm^2	Jantan and Zaki (1999)
Melissa officinalis L.	*An. stephensi*		1%	Oshaghi et al.(2003)
Minthostachys mollis	*Ae. aegypti*	60 min	50 %	Gillij et al. (2008)
Nepeta parnassica (vegetative stage)	*Cx.pipiens*	88.5 %	10 mg	Gkinis et al. (2003)
Pinus longifolia	*An. culicifacies*	100 %	Pure oil (1 ml)	Ansari et al. (2005)
	Cx. quinquefasciatus	97.4 %		
Piper aduncum	Ae. aegypti			Misni et al. (2008)
Pogostemon cablin	*Ae. aegypti*	71.4%	0.0047 mg cm^2	Jantan and Zaki (1999)
Rosmarinus officinalis	*Ae. aegypti*	90 min	50%	Gillij et al. (2008)
Tagetes minuta		90 min	25 %	
Zanthoxylum piperitum + 5% vanillin	*Ae. aegypti* (In laboratory study)	2.5 h*	0.1 ml of oil in 3x10 cm skin area	Kamsuk et al. (2006)
	Ae. gardnerii, *An. barbirostris*, *Armigeres subalbatus*, *Cx. tritaeniorhynchus*, *Cx. gelidus*, *Cx. vishnui* and *Mansonia uniformis*	100% (for 120 min) (in field condition)		

*Median complete protection time

The mosquito repellent property of volatile oils is measured in terms of total protection time. *Piper aduncum* essential oil gave 95.2% protection against *Ae. albopictus* bites under laboratory conditions (Misni et al., 2009); the protection was reduced to 83.3% after 4 h, 64.5% after 6 h, and 51.6% after 8 h postapplication. Deet is used as standard reference in the repellent bioassay studies which involves plant volatile oils or volatile compounds. Oshaghi et al. (2003) compared the effectiveness of lemon and melissa

oils with Deet and reported that lemon (92.70%) and melissa (92.67%) oils gave less protection than Deet (97%) against *An. stephansi* in guinea-pigs; however these differences were not significant. Tawatsin et al. (2001) extracted volatile oils from four plant species namely turmeric (*Curcuma longa*), kaffir lime (*Citrus hystrix*), citronella grass (*Cymbopogon winterianus*) and hairy basil (*Ocimum americanum*) by steam distillation method and evaluated the repellent activity against three mosquito vectors *Ae. aegypti*, *A. dirus* and *Cx. quinquefasciatus*. They found that the volatile oils from turmeric, citronella grass and hairy basil significantly gave maximum protection from three mosquito species and the repellency was increased for up to eight hours when 5% vanillin was added with the oils. They also reported that the standard repellent DEET gave protection for at least eight hours against only two mosquito species *Ae. aegypti* and *Cx. quinquefasciatus* but DEET with 5% vanillin gave protection against all the three mosquito species for at least eight hours.

Das and Ansari (2003) have reported that 1 ml of the essential oil of *Cymbopogan martinii martinii* var *sofia* oil when applied on the body parts gave 8 (98.7%) and 6 h (96.52%) of protection in indoor and outdoor respectively against *An. sundaicus* when tested for a period of 12 h. They reported that palmarosa oil contained geraniol (76.15%) as the major component.

Maguranyi et al. (2009) evaluated the repellency of essential oils from 11 Australian native plants against *Ae. aegypti, Cx. quinquefasciatus*, and *Cx. annulirostris* under laboratory conditions. Based on the preliminary results they selected the three most effective oils, mixed them and tested the repellency. *Prostanthera melissifolia* essential oil gave the longest protection time (110 min.) against *Cx. quinquefasciatus* and the repellency against *Ae. aegypti* was increased when the blend of *Leptospermum petersonii*, *Prostanthera melissifolia*, and *Melaleuca alternifolia* was tested at 5% v/v. They recommended the use of the blend of the above three oils as a short term repellent or under conditions of low mosquito abundance.

The effectiveness of mosquito repellents depends on many environmental factors. According to Barnard et al. (1998) the effect of repellents can vary greatly among mosquito species. A repellent will not protect all users equally and several factors such as species of the mosquito, density of organisms in the immediate surroundings, user's age, sex and biochemical attractiveness to the biting insect, ambient temperature, humidity and wind speed determine the effectiveness of a repellent (Golenda et al., 1999; Maibach et al., 1966; Muirhead-Thomson, 1951; Fradin, 2001; Fradin and Day, 2002). The essential oils obtained from different parts or during different stages of the same plant may have variations in their components, which is considered as a major cause for their differential activities. Gkins et al. (2003) isolated essential oils from the aerial parts of *Nepeta parnassica* at both vegetative and flowering stages and evaluated them against *Cx. pipiens molestus*. They recorded a significant repellent activity at 10 mg of oil obtained from the vegetative stage of *N. parnassica* when compared with the flowering stage, which was due to the qauantitative variation in the components of both oils. The main metabolites of vegetative-stage oil were recorded as 4a*α*,7*α*,7aβ-nepetalactone (22.0%), 1,8-cineole (21.1%), *α*-pinene (9.5%) and 4a*α*,7β,7aβ-nepetalactone (7.9%).

ENHANCING THE REPELLENT ACTIVITY OF VOLATILE OILS

Most of the essential oils have a short protective duration against mosquitoes due to their high volatility (Kamsuk et al., 2006). This limitation can be overcome by making a formulation with some fixatives like liquid paraffin (Oyedele et al. 2002) vanillin (Tawatsin et al. 2001), salicyluric acid (Blackwell et al., 2003), and mustard and coconut oils (Das et al. 2003). In a field study it was observed that the essential oil of *Zanthoxylum piperitum* fruits with 5% vanillin provided better protection against a wide range of mosquito populations than oil without vanillin; vanillin-oil combination was also found to be more effec-

tive than 25% DEET (Kamsuk et al., 2006). Choochote et al. (2007) have reported the repellent property of essential oils of fruits, rhizomes and seeds of ten plants namely *Amomum xanthioides*, *Curcuma zedoaria*, *Kaempferia galanga*, *Anethum graveolens*, *Apium graveolens*, *Carum carvi*, *Foeniculum vulgare*, *Piper longum*, *Zanthoxylum limonella* and *Zanthoxylum piperitum* against *Ae. aegypti*. The complete protection time of individual oils and mixtures of two effective oils with and without 10 per cent vanillin was studied. *Z. piperitum*, *A. graveolens* and *K. galangal* provided repellency against *A. aegypti* with median complete-protection times of 1, 0.5 and 0.25 h, respectively and the protection time of *Z. piperitum*, *Z. limonella*, *K. galangal* and *C. zedoaria* increased significantly when 10% vanillin was incorporated. The highest median complete protection time (2.5 h) was recorded by *Z. piperitum* oil +10% vanillin. The mixtures of oils were not found to be so effective. Volatile compounds citronellal, citronellol, and geranio were isolated from essential oil of *Cymbopogon winterianus* (Java citronella) and made into a air freshener gel for slow release of volatile compound. Geraniol and citronellol recorded 78 and 77% repellent activity, respectively and the activity was maintained up to 16.82 and 12.77 days for geraniol and citronellol, respectively in gel form (Eden et al., 2020).

CONCLUSIONS

Plant volatile oils and volatile compounds are promising mosquito control products. They are generally safe to human beings and other mammals. The mosquito control property of volatile oils is due to the presence of volatile compounds. From this review it is clear that some compounds like 1,8-cineole, linalool, limonene, eugenol and thymol have been frequently reported as effective larvicides and repellents against mosquitoes. Research on improving the efficacy of volatile oils is currently getting more importance. More research is needed for developing novel volatile oil formulations with controlled release technology and broad range activity against all vector mosquito species.

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REFERENCES

Andrade, C.F.S. & Bueno, V.S. (2001). Evaluation of electronic mosquito-repelling devices using *Aedes albopictus* (Skuse) (Diptera: Culicidae). Neotropical Entomology, 30(3), 497-499

Ansari, Md., Mittal, P., Razdan, R. & Sreehari, U. (2005). Larvicidal and mosquito repellent activities of Pine (*Pinus longifolia* Family: Pinaceae) oil. Journal of vector borne diseases, 42, 95-99.

Autran, E.S., Neves, I.A., da Silva, C.S.B., Santos, G.K.N., da Câmara, C.A.G. & Navarro, D.M.A.F. (2009). Chemical composition, oviposition deterrent and larvicidal activities against *Aedes aegypti* of essential oils from *Piper marginatum* Jacq. (Piperaceae). Bioresource Technology, 100, 2284-2288.

Badolo, A., IIboudo-Sanogo, E., Ou´edraogo, P.A. & Costantini, C. (2004). Evaluation of the sensitivity of *Aedes aegypti* and *Anopheles gambiae* complex mosquitoes to two insect repellents: DEET and KBR 3023. Tropical Medicine & International Health, 9, 330.

Barnard, D.R. & Xue, R.D. (2004). Laboratory evaluation of mosquito repellents against *Aedes albopictus*, *Culex nigripalpus*, and *Ochierotatus triseriatus* (Diptera: Culicidae). Journal of Medical Entomology, 41(4),726-30.

Barnard, D.R., Posey, K.H., Smith, D. & Schreck, C.E. (1998). Mosquito density, biting rate and cage size effects on repellent tests. Medical and Veterinary Entomology, 12(1), 39-45

Becker, N., Petric, D., Zgomba, M., Boase, C., Dahl, C., Lane, J. & Kaiser, A. (2003). *Mosquitoes and their control*. Kluwer Academic/Plenum Publishers: New York.

Ben-Dov, E. (2014) *Bacillus thuringiensis* sub sp. *israelensis* and its dipteran-specific toxins. Toxins, 6, 1222–1243.

Blackwell, A., Stuart, A.E. & Estambale, B.A. (2003). The repellent and antifeedant activity of *Myrica gale* oil against *Aedes aegypti* mosquitoes and its enhancement by the addition of salicyluric acid. The Journal of the Royal College of Physicians of Edinburgh, 33, 209

Brandão, B.L., Santos, L.L., Martins, R.L., Rodrigues, A.B.L., Rabelo, E.de.M., Galardo, A.K.R. et al. (2021). Larvicidal evaluation against *Aedes aegypti* and antioxidant and cytotoxic potential of the essential oil of *Tridax procumbens* L. leaves. The Scientific World Journal, Vol.2021, Article ID 2172919 (https://doi.org/10.1155/2021/2172919)

Brattsten, L.B., Hamilton, G.C. & Sutherland, D.J. (2009). Insecticides recommended for mosquito control in New Jersey. In: *New Jersey Agricultural Experiment Station,* Publication No. P-08001-01-08.

Campbell, R.L. & Sullivan, W.W. (1993). The relative toxicity of nicotine, anabasine, methyl anabasine and lupinine for culicine mosquito larvae. Journal of Economic Entomology, 26, 500–509.

Cansian, R.L., Staudt, A., Bernardi, J.L., Puton, B.M.S., Oliveira, D., de Oliveira, J.V. et al. (2021). Toxicity and larvicidal activity on *Aedes aegypti* of citronella essential oil submitted to enzymatic esterification. Brazilian Journal of Biology, 83, e244647

Carvalho, A.F.U., Melo, V.M.M. & Craveiro, A.A., Machado, M.I.L., Bantim, M.B., Rabelo, E.F. (2003). Larvicidal activity of the essential oil from *Lippia sidoides* Cham. against *Aedes aegypti* Linn. Memórias do Instituto Oswaldo Cruz, 98(4), 569-571

Cavalcanti, E.S.B., de Morais, S.M., Lima, M.A.A. & Santana, E.W.P. (2004). Larvicidal activity of essential oils from Brazilian plants against *Aedes aegypti* L. Memorias do Instituto Oswaldo Cruz*,* Rio de Janeiro, 99(5), 541-544.

Chantawee, A. & Soonwera, M. (2018). Efficacies of four plant essential oils as larvicide, pupicide and oviposition deterrent agents against dengue fever mosquito, *Aedes aegypti* Linn. (Diptera: Culicidae). Asian Pacific Journal of Tropical Biomedicine, 8(4), 217-225

Chantraine, J.M., Laurent, D., Ballivian, C., Saavedra, G., Ibanez, R. & Vilaseca, L.A. (1998). Insecticidal activity of essential oils on *Aedes aegypti* larvae. Phytotherapy Research, 12, 350–354.

Cheng, S.S., Chang, H.T., Chang, S.T., Tsai, K.H. & Chen, W.J. (2003). Bioactivity of selected plant essential oils against the yellow fever mosquito *Aedes aegypti* larvae. Bioresource Technology, 89, 99–102

Cheng, S.S., Liu, J.Y., Tsai, K.H., Chen, W.J. & Chang, S.T. (2004). Chemical composition and mosquito larvicidal activity of essential oils from leaves of different *Cinnamomum osmophloeum* provenances. Journal of Agricultural and Food Chemistry*,* 52*,* 4395–400

Cheng, S.S., Liu, J.Y., Huang, C.G., Hsui, Y.R., Chen, W.J. & Chang, S.T. (2009). Insecticidal activities of leaf essential oils from *Cinnamomum osmophloeum* against three mosquito species. Bioresource Technology, 100(1), 457-464.

Chogo, J.B. & Crank, G. (1981). Chemical composition and biological activity of the Tanzanian plant *Ocimum suave*. Journal of Natural Products (Lloydia), 44, 308–311.

Choochote, W., Chaiyasit, D., Kanjanapothi, D., Rattanachanpichai, E., Jitpakdi, A., Tuetun, B. et al. (2005). Chemical composition and antimosquito potential of rhizome extract and volatile oil derived from *Curcuma aromatica* against *Aedes aegypti* (Diptera: Culicidae). Journal of vector ecology, 30(2), 302-309.

Choochote, W., Chaithong, U., Kamsuk, K., Jitpakdi, A., Tippawangkosol, P., Tuetun, B. et al. (2007). Repellent activity of selected essential oils against *Aedes aegypti*. Fitoterapia,78, 359-364

Chung, I.M., Kim, M.Y., Park, S.D., Park, W.H. & Moon, H.I. (2009). *In Vitro* evaluation of the antiplasmodial activity of *Dendropanax morbifera* against chloroquine-sensitive strains of *Plasmodium falciparum.* Phytotherapy Research, 23(11), 1634-1637.

Corbet, S.A., Danahar, G.W., King, V., Chalmers, C.L. & Tiley, C.F. (1995). Surfactant-enhanced essential oils as mosquito larvicides. Entomologia Experimentalis et Applicata, 75(3), 229-236

Curtis, C.F., Lines, J.D., Baolin, Lu & Renz, A. (1991). Natural and synthetic repellents. In: Curtis, C.F. (Ed.), Control of disease vectors in the community. Wolfe, London, pp. 75–92.

Darvin, S.S., Ganesan, P., Stalin, A., Rajan, S., Gabriel Paulraj, M., Balakrishna, K. et al. (2019). Effect of tiliamosine, a bis, benzylisoquinoline alkaloid isolated from *Tiliacora acuminata* (Lam.) Hook. f. & Thom on the immature stages of filarial mosquito *Culex quinquefasciatus* Say (Diptera: Culicidae), Experimental Parasitology, 204, 107719 (https://doi.org/10.1016/j.exppara.2019.107719).

Das, M.K. & Ansari, M.A. (2003). Evaluation of repellent action of *Cymbopogan martinii martinii* Stapf var *sofia* oil against *Anopheles sundaicus* in tribal villages of Car Nicobar Island, Andaman & Nicobar Islands, India. Journal of Vector Borne Diseases, 40, 100–104

Das, N.G., Baruah, I., Talukdar, P.K. & Das, S.C. (2003). Evaluation of botanicals as repellents against mosquitoes. Journal of Vector Borne Diseases, 40, 49–53

Debboun, M., Strickman, D., Solberg, V.B., Wilkerson, R.C., McPherson, K.R., Golenda, C. et al. (2000). Field evaluation of DEET and piperidine repellent against *Aedes communis* (Diptera: Culicidae) and *Simulium venustrum* (Diptera: Simulidae) in the Adirondack mountains of New York. Journal of Medical Entomology, 37, 919–923.

Duke, J.A. (2004). Dr. Duke's phytochemical and ethnobotanical databases. Available online at http://www.ars-grin.gov/duke/ (accessed on 9 June, 2008).

Eden, W.T., Alighiri, D., Supardi, K.I. & Cahyono, E. (2020). The mosquito repellent activity of the active component of air freshener gel from Java Citronella oil (*Cymbopogon winterianus*). Journal of Parasitology Research, vol. 2020, article ID 9053741, (https://doi.org/10.1155/2020/9053741)

Edwards, D.L. & Johnson, C.E. (1987). Insect–repellent-induced toxic encephalopathy in a child. Clinical Pharmacology, 6, 496–498.

El-Akhal, F., Ramzi, A., Farah, A., Zoubi, Y.E., Benboubker, M., Taghzouti, K. & Lalami, A. El. O. (2021). Chemical composition and larvicidal activity of *Lavandula angustifolia* subsp. *angustifolia* and *Lavandula dentata* spp. *dentata* essential oils against *Culex pipiens* larvae, vector of West Nile virus. Psyche: A Journal of Entomology, Vol. 2021, Article ID 8872139, 7 pages, https://doi.org/10.1155/2021/8872139

Eleni, M., Antonios, M., George, K., Leandros, S.A. & Prokopios, M. (2009). High quality bergamot oil from Greece: Chemical analysis using chiral gas chromatography and larvicidal activity against the West Nile Virus vector. Molecules, 14*,* 839-849

El Hag, E. A., El Nadi, A. H. & Zaitoon, A. A. (1999). Toxic and growth retarding effects of three plant extracts on *Culex pipiens* larvae (Diptera: Culicidae). Phytotherapy Research, 13, 388-392.

El Hag, E.A., Abd-El Rahman, El-Nadi, H. & Zaitoon, A.A. (2001). Effects of methanolic extracts of neem seeds on egg hatchability and larval development of *Culex pipiens* mosquitoes. Indian Veterinary Journal, 78, 199-201.

Filho, A.A.P., D'Ávila Pessoa, G.C., Yamaguchi, L.F., Stanton, M.A., Serravite, A.M., Pereira, R.H.M. et al. (2021). Larvicidal activity of essential oils from *Piper* species against strains of *Aedes aegypti* (Diptera: Culicidae) resistant to pyrethroids. Frontiers in Plant Science, 12: 685864. DOI: 10.3389/fpls.2021.685864

Fradin, M.S. (2001). Insect repellents. In S.E. Wolverton (Ed.), Comprehensive dermatologic drug therapy (pp. 717-734). Philadelphia: W.B. Saunders.

Fradin, M.S. & Day, J.F. (2002). Comparative efficacy of insect repellents against mosquito bites. The New England Journal of Medicine, 347(1), 13-18

Ganesan, P., Stalin, A., Gabriel Paulraj, M., Balakrishna, K., Ignacimuthu, S. & Al-Dhabi, N.A. (2018). Biocontrol and non-target effect of fractions and compound isolated from *Streptomyces rimosus* on the immature stages of filarial vector *Culex quinquefasciatus* Say (Diptera: Culicidae) and the compound interaction with Acetylcholinesterase (AChE1). Ecotoxicology and Environmental Safety, 4, 161:120-128

Gillij, Y.G., Raquel, G. & Julio, Z. (2008). Mosquito repellent activity of essential oils of aromatic plants growing in Argentina. Bioresource technology, 99(7), 2507-2515

Gkinis, G., Tzakou, O., Iliopoulou, D. & Roussis, V. (2003). Chemical composition and biological activity of *Nepeta parnassica* oils and isolated Nepetalactones. Zeitschrift für Naturforschung, 58c, 681- 686

Golenda, C.F., Solberg, V.B., Burge, R., Gambel, J.M. & Wirtz, R.A. (1999). Gender related efficacy difference to an extended duration formulation of topical N,N-diethyl-m-toluamide (DEET). American Journal of Tropical Medicine and Hygiene, 60, 654-657.

Hemingway, J. & Ranson, H. (2000). Insecticide resistance in insect vectors of human disease. Annual Review of Entomology, 45, 371-391.

Hemingway, J., Field, L. & Vontas, J. (2002). An overview of insecticide resistance. Science, 298, 96-97.

Jantan, I. & Zaki, Z.M. (1999). Development of environment-friendly insect repellents from the leaf oils of selected Malaysian plants. ASEAN Review of Biodiversity and Environmental Conservation, VI, 1-7

Kamsuk, K., Choochote, W., Chaithong, U., Jitpakdi, A., Tippawangkosol, P., Riyong, D. et al. (2006). Effectiveness of *Zanthoxylum piperitum*-derived essential oil as an alternative repellent under laboratory and field applications. Parasitology Research, 100(2), 339-45.

Kelm, M.A. & Nair, M.G. (1998). Mosquitocidal compounds and a Triglyceride, 1,3-Dilinoleneoyl-2-palmitin, from *Ocimum sanctum*. *Journal of Agricultural and Food Chemistry*, *46*(8), 3092–3094

Khater, H.F. & Shalaby. A.A.S. (2007). Potential of biologically active plant oils for controlling of *Culex pipiens* (Diptera:Culicidae). Acta Scientiae Veterinariae, 35(2), 153-160

Klocke, J.A., Darlington, M.V. & Balandrin, M.F. (1987). 1,8-Cineole (Eucalyptol), a mosquito feeding and ovipositional repellent from volatile oil of *Hemizonia fitchii* (Asteraceae). Journal of Chemical Ecology, 13, 2131–2141

Knio, K.M., Usta, J., Dagher, S., Zournajian, H. & Kreydiyyeh, S. (2008). Larvicidal activity of essential oils extracted from commonly used herbs in Lebanon against the seaside mosquito, *Ochlerotatus caspius.* Bioresource Technology, 99(4), 763-768

Lacey, L.A., Grzywacz, D., Shapiro-Ilan, D.I., Frutos, R., Brownbridge, M. & Goettel, M.S. (2015). Insect pathogens as biological control agents: Back to the future. Journal of Invertebrate Pathology, 132, 1–41.

Li, M.X., Ma, Y.P., Zhang, H.X., Sun, H.Z., Su, H.H., Pei, S.J. & Du, Z.Z. (2021). Repellent, larvicidal and adulticidal activities of essential oil from Dai medicinal plant *Zingiber cassumunar* against *Aedes albopictus*. Plant Diversity, 43, 317-323.

Lucia, A., Audino, P.G., Seccacini, E., Licastro, S., Zerba, E. & Masuh, H. (2007). Larvicidal effect of *Eucalyptus grandis* essential oil and turpentine and their major components on *Aedes aegypti* larvae. Journal of American Mosquito Control Association, 23(3), 299-303.

Maguranyi, S.K., Webb, C.E., Mansfield, S. & Russell, R.C. (2009). Are commercially available essential oils from Australian native plants repellent to mosquitoes? Journal of American Mosquito Control Association, 25(3), 292-300

Mahanta, S. & Khanikor, B. 2021. Mosquitocidal activity of twenty-eight plant essential oils and their binary mixtures against *Culex quinquefasciatus,* (Diptera: Culicidae). Heliyon, 7(2), e06128 (https://doi.org/10.1016/j.heliyon.2021.e06128)

Maia, J.D., Corte, R.L., Martinez, J., Ubbink, J. & Prata, A.S. (2019). Improved activity of thyme essential oil (*Thymus vulgaris*) against *Aedes aegypti* larvae using a biodegradable controlled release system. Industrial Crops and Products, 136, 110-120,

Maibach, H.I., Skinner, W.A., Strauss, W.G. & Khan, A.A. (1966) Factors that attract and repel mosquitoes in human skin. JAMA, 196, 263-266.

Massebo, F., Tadesse, M., Bekele, T., Balkew, M. & Michael, T.G. (2009). Evaluation on larvicidal effects of essential oils of some local plants against *Anopheles arabiensis* Patton and *Aedes aegypti* Linnaeus (Diptera, Culicidae) in Ethiopia. African Journal of Biotechnology, 8 (17), 4183-4188

Michaelakis, A., Theotokatos, S.A., Koliopoulos, G. & Chorianopoulos, N.G. (2007). Essential oils of *Satureja* species: Insecticidal effect on *Culex pipiens* larvae (Diptera: Culicidae). Molecules, 12, 2567-2578

Misni, N., Sulaiman, S. & Othman, H. (2008). The repellent activity of *Piper aduncum* Linn (Family: Piperaceae) essential oil against *Aedes aegypti* using human volunteers. Journal of Tropical Medicine and Parasitology, 31, 63-69

Misni, N., Sulaiman, S., Othman, H., Omar, B., (2009). Repellency of essential oil of *Piper aduncum* against *Aedes albopictus* in the labora-

tory). Journal of the American Mosquito Control Association, 25(4), 442-447

Mohammadreza, V. 2008. Essential oil composition and biological activity of *Ziziphora clinopodioides* Lam. from Iran. American-Eurasian Journal of Sustainable Agriculture, 2(1), 69-71

Mondal, M. & Khalequzzaman, M. (2006). Toxicity of essential oils against red flour beetle, *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). Journal of Bio Science, 14, 43-48

Monisha, D., Sivasankar, V., Prabhakaran, M. & Gabriel Paulraj, M. (2020). Mosquito larvicidal activity of *Enhalus acoroides* (L.f) Royle and *Halophila ovalis* (R. Br) Hook. f. against the deadly vectors *Aedes aegypti* and *Culex quinquefasciatus*. South African Journal of Botany, 133(1), DOI:10.1016/j.sajb.2020.06.021.

Morais, S.M., Facundo, V.A., Bertini, L.M., Cavalcanti, B.E.S., Francisco, J.A., Ferreira, S.A. et al. (2007). Chemical composition and larvicidal activity of essential oils from *Piper* species. Biochemical Systematics and Ecology, 35, 670–675.

Mossa, A.T.H. (2016). Green pesticides: Essential oils as biopesticides in insect-pest management. Journal of Environmental Science and Technology, 9(5), 354–378.

Muirhead-Thomson, R.C. (1951). The distribution of anopheline mosquito bites among different age groups: A new factor in malaria epidemiology. BMJ, 1, 1114-1117.

Nazar, S., Ravikumar, S., Williams, G.P., Ali, M.S. & Suganthi, P. (2009). Screening of Indian coastal plant extracts for larvicidal activity of *Culex quinquefasciatus*. Indian Journal of Science and Technology, 2(3), 24-27

Nour, A.H., Elhussein, S.A., Osman, N.A., Nour, A.H. & Yusoff, M.M. (2009). A Study of the essential oils of four Sudanese accessions of basil (*Ocimum basilicum* L.) against *Anopheles* mosquito larvae. American Journal of Applied Sciences, 6 (7), 1359-1363.

Odalo, J.O., Omolo, M.O., Malebo, H., Angira, J., Njeru, P.M., Ndiege, I.O. et al. (2005). Repellency of essential oils of some plants from the Kenyan coast against *Anopheles gambiae*. Acta Tropica, 95, 210-218.

Omolo, M.O., Okinyo, D., Ndiege, I.O., Lwande, W. & Hassanali, A. (2004). Repellency of essential oils of some Kenyan plants against *Anopheles gambiae.* Phytochemistry, 65, 2797–802

Oshaghi, M.A., Ghalandari, R., Vatandoost, H., Shayeghi, M., Kamali-nejad, M., Khaledi, H.T. et al. (2003). Repellent effect of extracts and essential oils of *Citrus limon* (Rutaceae) and *Melissa officinalis* (Labiatae) against main malaria vector, *Anopheles stephensi* (Diptera: Culicidae). Iranian Journal of Public Health, 32(4), 47-52.

Oyedele, A.O., Gbolade, A.A., Sosan, M.B., Adewoyin, F.B., Soyelu, O.L. & Orafidiya, O.O. (2002). Formulation of an effective mosquito-repellent topical product from Lemongrass oil. Phytomedicine, 9(3), 259-262

Pandey, V., Agrawal, V., Raghavendra, K. & Dash, A.P. (2007). Strong larvicidal activity of three species of *Spilanthes* (Akarkara) against malaria (*Anopheles stephensi* Liston, *Anopheles culicifacies*, species C) and filarial vector (*Culex quinquefasciatus* Say). Parasitology Research, 102, 171-174.

Paulraj, M.G. & Ignacimuthu, S. (2007). Effect of some volatile oils on life stages and orientation behavior of *Lasioderma serricorne* (Fab.) (Coleoptera: Anobiidae). In S. Ignacimuthu and S. Jayaraj (Eds.), Biotechnology and Insect Pest Management (pp. 171-176), Elite Publishing House Pvt. Ltd..

Pavunraj, M., Paulraj, M.G. & Ignacimuthu, S. (2007). Effect of plant volatile oils in protecting stored peanuts against *Tribolium castaneum* (Herbst.) (Coleoptera: Tenebrionidae) infestation. Insect Environment, 13(1), 3-4.

Penfold, A.R. & Morrison, F.R. (1952). Some Australian essential oils in insecticides and repellents. Soap, Perfumery Cosmetics, 52, 933-934.

Peterson, C. & Coats, J. (2001). Insect repellents – past, present and future. Pesticide Outlook, 154–158.

Pitasawat, B., Champakaew, D., Choochote, W., Jitpakdi, A., Chaithong, U., Kanjanapothi, D. et al. (2007). Aromatic plant-derived essential oil: An alternative larvicide for mosquito control. Fitoterapia, 78(3), 205-210

Qui, H., Jun, H.W. & McCall, J.W. (1998). Pharmacokinetics, formulation, and safety of insect repellent *N*,*N*-diethyl-3- methylbenzamide (DEET): A review. Journal of American Mosquito Control Association, 14, 12–27.

Ranaweera, S. S. & Dayananda, K.R. (1996). Mosquito-larvicidal activity of some Sri-Lankan plants Journal of the National Science Council of Sri Lanka, 24 (2), 63-69.

Robbins, P.J. & Cherniack, M.G. (1986). Review of biodistribution and toxicology of the insect repellent *N*,*N*-diethyl-*m*-toluamide (DEET). Journal of Toxicology and Environmental Health, 18, 503–525.

Shaalan, E.A.S., Canyon, D., Younes, M.W.F, Wahab, H.A. & Mansour, A.H. (2005). A review of botanical phytochemicals with mosquitocidal potential. Environment International, 31, 1149-1166.

Sivanandhan, S., Ganesan, P., David, R.H.A., Gabriel Paulraj, M. & Ignacimuthu, S. (2019). Mosquitocidal activity of the pale brittle stem mushroom *Psathyrella candolleana* (Agaricales) against three vector mosquitoes. International Journal of Medicinal Mushrooms, 21(7), 725-734.

Sivanandhan, S., Ganesan, P., Stalin, A., Gabriel Paulraj, M., Rajan, S., Balakrishna, K. et al. (2021). Mosquitocidal effect of monoterpene ester and its acetyl derivative from *Blumea mollis* (D. Don) Merr against *Culex quinquefasciatus* (Diptera: Culicidae) and their *in silico* studies. Experimental Parasitology, 223, 108076 (https://doi.org/10.1016/j.exppara.2021.108076).

Tawatsin, A., Wratten, S.D., Scott, R.R., Thavara, U. & Techadamrongsin, Y. (2001). Repellency of volatile oils from plants against three mosquito vectors. Journal of vector ecology, 26(1), 76-82.

Thangam, T.S. & Kathiresan, K. (1994) Studies on mosquito larvicidal activity of *Rhizophora apiculata*. International Journal of Pharmacognosy, 32(1), 33-36.

Tiwary, M., Naik, S.N., Tewary, D.K., Mittalc, P.K. & Yadav, S. (2007). Chemical composition and larvicidal activities of the essential oil of *Zanthoxylum armatum* DC (Rutaceae) against three mosquito vectors. Journal of Vector Borne Diseases 44, 198–204.

Traboulsi, A.F., Taoubi, K., El-Haj, S., Bessiere, J.M. & Rammal, S. (2002). Insecticidal properties of essential plant oils against the mosquito *Culex pipiens molestus* (Diptera: Culicidae). Pest Management Science, 58, 491–5.

Traboulsi, A. F., El-Haj, S., Tueni, M., Taoubi, K., Nader, N. A. & Mrad, A. (2005). Repellency and toxicity of aromatic plant extracts against the mosquito *Culex pipiens molestus* (Diptera: Culicidae). Pest Management Science, 61, 597-604.

Trigg, J.K. (1996). Evaluation of *Eucalyptus*-based repellent against *Anopheles* spp. in Tanzania. Journal of American Mosquito Control Association, 12, 243–246.

Tripathi, A.K., Prajapati, V., Ahmad, A., Aggarwal, K.K. & Khanuja, S.P.S. (2004). Piperitenone oxide as toxic, repellent, and reproduction retardant toward malarial vector *Anopheles stephensi* (Diptera: Anophelinae). Journal of Medical Entomology, 41(4), 691–698.

Tyagi, B.K., Munirathinam, A. & Venkatesh, A. (2015). A catalogue of Indian mosquitoes. International Journal of Mosquito Research, 2(2), 50-97

Walker, T.W., Robbert, L.L., Copeland, R.A., Githeko, A.K., Wirtz, R.A., Githure, J.I. et al. (1996). Field evaluation of arthropod repellents, DEET and a piperidine compound, A13- 37220, against *Anopheles funestus* and *Anopheles arabiensis* in West Kenya. Journal of American Mosquito Control Association, 12, 172–176.

Wood, A. (2003). Compendium of pesticide common names: Insecticides. (http://www.alanwood.net/pesticides/index.htm).

Xu, Y., Qin, J., Wang, P., Li, Q., Yu, S., Zhang, Y. & Wang, Y. (2020). Chemical composition and larvicidal activities of essential oil of *Cinnamomum camphora* (L.) leaf against *Anopheles stephensi*. Journal of the Brazilian Society of Tropical Medicine, Vol.:53:e20190211: doi: 10.1590/0037-8682-0211-2019

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Dransfield, E., Martin, J. F., Fisher, A., Nute, G. R., Zygyiannis, D., Stamataris, C., et al. (2000). Home placement testing of lamb conducted in six countries. Journal of Sensory Studies, 15(4), 421–436.

Beltran, E., Pla, R., Yuste, M., & Mor-Mur, M. (2003). Lipid oxidation of pressurized and cooked chicken: Role of sodium chloride and mechanical processing on TBARS and hexanal values. Meat Science, 64(1), 19–25.

Mann, N. (2000). Dietary lean red meat and human evolution. European Journal of Clinical Nutrition, 39, 71–79.

Johansson, J. K. (1989). Determinants and effects of the use of 'made in' labels. International Marketing Review, 6, 47–58.

Scott, J. M. (1999). Folate and vitamin B12. Proceedings of the Nutrition Society, 58, 441–448.

Faustman, C., & Cassens, R. G. (1990). The biochemical basis for discoloration in fresh meat: A review. Journal of Muscle Foods, 1, 217–243.

Ramanathan, R., Konda, M. K. R., Mancini, R. A., & Faustman, C. (2009). Speciesspecific effects of sarcoplasmic extracts on lipid oxidation in vitro. Journal of Food Science, 74, C73–C76.

References to a conference:

Savell, J. W., & Shackelford, S. D. (1992). The significance of tenderness to the meat industry. In Proceedings of the 45th Reciprocal Meat Conference (pp. 43–46). Chicago, IL.

Joseph, P., Suman, S. P., Li, S., Beach, C. M., & Claus, J. R. (2008). Mass spectrometric characterization and thermostability of turkey myoglobin. In Proceedings of 61st annual reciprocal meat conference, Gainesville, FL. Abstract no. 87.

References to a book:

Meilgaard M., Civille G.V., & Carr T.B. (1999). Sensory Evaluation Techniques. (3rd ed.). CRC Press, Printed in USA.

Strunk, W., Jr., & White, E. B. (1979). The elements of style. (3rd ed.). New York: Macmillan, (Chapter 4).

Morgan, J. B., Cannon, J. B., McKeith, F. K., Meeker, D., & Smith, G. C. (1993). National pork chain quality audit (packer-processor-distributor). Final Report to the National Pork Producers Council.

USDA. (1997). USDA advises consumers to use a meat thermometer when cooking hamburger. FSIS News and Information Bulletin. FSIS, USDA. Washington, DC.

USDA-FSIS (2005). Federal register notice: HACCP plan reassessment for mechanically tenderized beef products. Federal Register, 70, 30331–30334.

References to a chapter in an edited book:

Gudmundsson, M., & Hafsteinsson, H. (2002). New non-thermal techniques for processing seafood. In H. A. Bremner (Ed.), Safety and quality issues in fish processing (pp. 308–329). Cambridge, England: CRC Press, Woodhead Publishing Ltd.

Olson, J. C. (1977). Price as an informational cue: Effects on product evaluations. In A. G. Woodside, J. N. Sheth, & P. D. Bennett (Eds.), Consumer and industrial buying behavior (pp. 267–286). New York: Elsevier.

Monroe, K. B., & Krishnan, R. (1985). The effect of price on subjective product evaluations. In J. Jacoby & J. C. Olson (Eds.), Perceived quality: How consumers view stores and merchandise (pp. 209–232). Toronto: Lexington.

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World Health Organisation. (1990). Diet, nutrition and the prevention of chronic disease. Technical Report Series No. 797. Geneva: WHO. Available at <http://www.who.int/dietphysicalactivity/publications/trs916/en/gsfao_global.pdf>. Accessed 10.06.10

National Bison Association. (2009). <http://www.bisoncentral.com>. Accessed 22.06.10

Bowater, F. J. (2001). Rapid carcass chilling plants compared to conventional systems. International Institute of Refrigeration. <www.fjb.co.uk>. Accessed 12.05.10.

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