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WHAT IS A THERAPEUTIC POTENTIAL OF N-ACETYLCYSTEINE IN LUNG SILICOSIS?

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Abstract

Lung silicosis is a serious pulmonary disease caused by an exposure of lung to inhaled silicon dioxide (SiO_2) or silica. Although pathomechanisms of the disease have not been fully elucidated, oxidative stress has been recognized as a fundamental factor triggering a fibrotizing inflammation leading to irreversible changes in lung tissue. Based on this knowledge, therapeutic potential of various antioxidants has been intensively discussed. Among them, N-acetylcysteine with its multiple anti-inflammatory and antioxidant actions and a long-term experience with its clinical use in various diseases appears as a very promising choice. The purpose of this article is to review the therapeutic effects of N-acetylcysteine particularly in relation to a lung injury and to point out a potential of N-acetylcysteine in the treatment of lung silicosis.

Key words: silica, lung silicosis, oxidative stress, N-acetylcysteine, antioxidants

INTRODUCTION

Lung silicosis is a form of interstitial lung fibrosis (pneumoconiosis) which may be potentially fatal or may lead to irreversible fibrotic changes. Lung silicosis is caused by an intensive and/or a long-term exposure of lung to inhaled silicon dioxide (SiO_2) or silica, especially to particles smaller than 10 μm in diameter, released from stones or sand in mining and industrial processing. Therefore, silicosis is a typical occupational disease in miners and stonemasons (1). While the development of lung silicosis is conditioned by a cumulative dose of silica exposure, there have been several forms of acute and chronic silicosis classified according to duration and intensity of exposure to respirable silica dust (2, 3). Despite lung silicosis is an old disease, there is no causal treatment. Patients are treated symptomatically using bronchodilators, antitusics, and mucolytics and an avoiding of further exposures to particulate silica is recommended. As the last therapeutic possibility after the exhaustion of other options, a lung transplantation may be suggested, however, a long-term survival after the lung transplantation is poor (3). Although pathomechanisms of the disease have not been fully elucidated and a complex action of several factors is proposed, oxidative stress has been recognized as a key factor triggering inflammation and fibrosis, finally leading to irreversible changes in the lung (4). An increasing number of studies has revealed a therapeutic potential of various herbal compounds and "classical" antioxidants. Among them, N-acetylcysteine with its multiple anti-inflammatory and antioxidant actions and a long-term experience with its wide clinical use appears as a valuable choice (5). The purpose of this article is, firstly, to provide a short review of the role of oxidative stress in the patho-

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physiology of silicosis. In addition, the article points out therapeutic effects of N-acetylcysteine (NAC) particularly in relation to a lung injury and presents possible benefits of NAC in the treatment of lung silicosis.

Oxidative stress in the pathophysiology of lung silicosis

The oxidative stress and oxidative stress-related changes are fundamental in the development of lung silicosis. Large quantities of reactive oxygen species (ROS) are formed already in the direct contact with silica crystals, particularly with those freshly cut, because of piezoelectric properties of silica crystals (6). Inhaled silica particles are rapidly recognized by the surface receptors of alveolar macrophages (AM) and engulfed by these cells. However, the system of lysosomes is not able to breakdown this type of particles, which results into a damage of lysosomal membrane and a discharge of lysosomal enzymes in the tissue. The released silica is subsequently engulfed by other AM and the process continues in a vitious cycle (7).

The released lysosomal enzymes, high concentrations of generated ROS, and activation of surface receptors on the immune cells stimulate pro-inflammatory pathways including nuclear factor (NF)-kappa (κ)B contributing to the activation of NLRP3 inflammasome with subsequent mitochondrial or cell apoptosis, pyroptosis, a highly pro-inflammatory type of cell death, and further generation of inflammation (4). Inflammation is associated with a production of additional quantities of ROS in the activated inflammatory cells which in turn stimulate the inflammation (8-10). The situation is further complicated with a silica-induced degradation of some antioxidant systems, e.g. peroxiredoxin (11). The perpetuation of this harmful process leads not only to a chronic lung inflammation but pro-inflammatory cytokines, e.g. interleukins (IL)-1 and IL-18, and tumor necrosis factor (TNF)α, stimulate the recruitment and proliferation of fibroblasts and mesenchymal cells to form fibroblastic foci and to produce the components of extracellular matrix including collagen, which results into an irreversible fibrotic scarring of the lung (12).

Antioxidants in the lung silicosis

Considering the role of excessive concentrations of ROS in the progression of silica-induced lung inflammation and fibrosis, the administration of antioxidants may be of benefit. In addition to the mitigation of oxidative stress, some antioxidants have a potential to influence cell apoptosis and/or to enhance autophagy, a special form of tissue-friendly elimination of damaged cells, toxic macromolecules, and injured organelles (13-15). While the potential of some phytomedicines with antioxidant actions has been recently published by us elsewhere (16), this article provides a review of therapeutic effects of NAC, a well-known and widely used antioxidant, in the lung injury generally and points out its possible benefits in the lung silicosis.

Effects of NAC

NAC is N-acetyl derivative of amino acid L-cysteine. Thanks to a content of thiol (-SH) group, NAC works as a direct scavenger of ROS, e.g. of hydrogen peroxide, hydroxyl radicals, and hypochlorous acid, or nitrogen dioxide, and inhibits the activity of cyclooxygenase-2 and membrane lipid peroxidation induced by inflammation (17). NAC is rapidly deacetylated to cysteine, a precursor of glutathione (GSH) synthesis in cells, and thereafter it regulates an intracellular redox status. NAC binds transition metal ions and heavy metal ions, forming complexes which are readily excreted from the body (18). NAC also exerts some anti-inflammatory and lung-protective actions as it mitigates a generation of pro-inflammatory cytokines TNFα, IL-1β and IL-6 by suppressing the activity of NF-κB (19). Besides potent antioxidant and anti-inflammatory effects, NAC reduces the viscosity and elasticity of mucus because of its ability to split disulphide bonds in high-molecular-weight glycoproteins in mucus (18), which is useful e.g. in cystic fibrosis. In addition to many positive pharmacological properties, a wide use of this drug is also related to its high stability and low price. Because of low bioavailability, NAC has a negligible toxicity. In standard dosing

with a maximum licensed oral dose for a chronic use of 600 mg/day, the treatment with NAC is well tolerated (20). Analyses of occurence of adverse effects in NAC-treated patients with chronic respiratory diseases showed no increase in the frequency of side effects compared to placebo-treated groups (21, 22). The side effects of oral NAC, such as nausea, vomiting, or diarrhea are rare and limited to very high concentrations (20). For instance, the administration of oral NAC for 22 weeks in a doubled dose than the maximum recommended (1,200 mg/day) in patients with chronic bronchitis caused only in one patient of 78 in total the adverse clinical symptoms such as dizziness, leg pain, headache, and palpitations which led to withdrawal from the study (20, 23). In randomized studies carried out on patients with a chronic obstructive pulmonary disease (COPD), the administration of oral NAC at a daily dose of 1,200 mg exerted an overall safety profile consistent with the established safety profile of 600 mg/day NAC treatment (24, 25). In very high doses of oral NAC (1,800 mg/day), a slightly higher frequency of mild gastrointestinal symptoms was found in patients with COPD (gastrointestinal symptoms in 5/23 of NAC-treated patients vs 1/22 of placebo-treated patients) (26), and a higher occurence of cardiac complaints was observed in NAC-treated patients with an idiopathic pulmonary fibrosis (IPF) (6.8% in NAC-treated vs 1.4% in placebo-treated patients) (27). However, a more recent study demonstrated that positive and adverse effects of NAC on patients with IPF depend on genotype characteristics (28). The occurence of adverse effects may be also related to the route of administration. For instance, in our experiments in rabbits with a meconium-induced acute lung injury, the intravenous administration of NAC at a dose of 10 mg/kg was associated with a short-term increase in blood pressure and changes in several parameters of the heart rate variability (29). Nevertheless, Meyer et al. compared the effects of three different doses (600 mg, 1,800 mg, and 4,800 mg) of intravenous NAC given to patients with IPF and healthy controls and found no differences in the occurence of adverse effects (30). Because of anticoagulant action and inhibition of platelet functions, the use of NAC should be considered in patients with bleeding disorders and anemia (20, 31).

Proposed mechanisms of action of NAC are listed in **Table 1**.

Table 1 Mechanisms of action of NAC (modified according to Ref. 5).

Mechanisms of NAC action	
Direct scavenging of ROS	Protection and repair of DNA
Restoration of GSH	Reduction of mitochondria apoptosis
Reduction of inflammation via suppression of NF-κB	Glutamate/dopamine homeostasis
Mucolytic action	Antiviral action
Metal chelation	Inhibition of vascular permeability
Stabilization of proteins	Increase in ATP and NO production

Abbreviations: ATP: adenosine triphosphate, DNA: deoxyribonucleic acid, GSH: glutathione, NAC: N-acetylcysteine, NF- B: nuclear factor kappa B, NO: nitric oxide, ROS: reactive oxygen species.

Therapeutical use of NAC

NAC has been clinically used for decades for the treatment of a wide variety of medical conditions (5), such as paracetamol overdose (32), metal-induced toxicity (33), and certain psychiatric disorders modulating glutamatergic, neurotropic, and inflammatory pathways (34). Animal studies showed that NAC can protect from oxidative stress and inflammation in many other conditions, such as a brain damage induced by transient cerebral ischemia (35), infection-induced pain and inflammation (36), or infiltration of thyroid gland by inflammatory cells in autoimmune thyroiditis (37). However, NAC may be of benefit in many

respiratory diseases, such as COPD, chronic bronchitis, cystic fibrosis, or acute respiratory distress syndrome (ARDS) including COVID-19-induced ARDS (38, 39). In our experiments, the intravenous administration of NAC significantly reduced the markers of oxidative stress and inflammation in rabbits with the meconium-induced acute lung injury (40, 41), while an additional improvement was observed in combination with an intratracheal delivery of exogenous surfactant (42, 43).

NAC in the lung silicosis

In vitro studies

In murine macrophage cell line 264.7 exposed to silica, a pretreatment with NAC decreased silica-induced TNFα mRNA and protein levels and mRNA levels of macrophage inflammatory protein (MIP)-2, MIP-1α, MIP-1β, and monocyte chemotactic protein (MCP)-1 (44). The authors concluded that the anti-inflammatory response to the administration of antioxidant NAC indicates a very close relationship between the silica-induced overproduction of ROS and the inflammation (44). This opinion was confirmed by other authors who found that silica exposure to rat2 fibroblast cell line caused a rapid degradation of peroxiredoxin, an important antioxidant system, and induced a degradation of NF-κB inhibitor IκB-α. The pretreatment of the cells with 1 mM NAC inhibited a suppression of IκB-α and blocked a silica-induced accumulation of ROS but had no effect on peroxiredoxins I and II (11). The silica-induced activation of NF-κB pathway leading to a two-fold increase in production of ROS was also demonstrated in murine peritoneal macrophage cell line RAW 264.7, while a pretreatment with 1 and 10 mM NAC effectively reduced activation of NF-κB (45).

In AM isolated from silica-instilled rats, silica elevated intracellular ROS concentrations, resulting in a decrease in intracellular GSH and cysteine and a sustained presence of apoptotic AM which were characterized by a decreased mitochondrial transmembrane potential, an increased mitochondrial release of cytochrome C, and activated caspase-9 and caspase-3 compared to control group. Silica induced production of IL-1β and TNFα in AM which was inhibited by NAC. NAC also prevented intracellular GSH depletion but not apoptosis in AM (13). Similarly, in rat AM exposed *in vitro* to silica, the silica-induced apoptosis was accompanied with lowering of intracellular and mitochondrial GSH which was effectively blocked by NAC as well as the production of IL-1β and TNFα by AM, however, NAC did not protect the cells from apoptosis (46).

In rat AM NR8383 cells, the exposure to silica induced both inflammation and autophagy. The pretreatment with NAC decreased the expressions of pro-inflammatory cytokine TNFα and pro-fibrotic transforming growth factor-β (TGF-β) but the absence of influencing PI3K/Akt/mTOR signaling autophagy pathway suggests that the anti-inflammatory response of NAC might be partially related to the inhibition of the release of lysosomal enzymes, the reduction of the stimulation of fibroblasts, eventually to the reduction of collagen and fibronectin synthesis by fibroblasts (47).

Of course, the value of the results obtained from *in vitro* studies is limited in comparison to the value of *in vivo* models or human studies. In *in vitro* measurements, the effects of NAC may be observed only in a sample of selected type of pulmonary cells without interactions with other lung cells or immune cells as it is possible in *in vivo* conditions. Based on these facts, it is impossible to transfer directly e.g. the dose of NAC used in *in vitro* study to *in vivo* experiments or to human study. Nevertheless, the measurements on isolated cell lines may bring valuable information on effects of the treatment agent on the cellular level, which may serve as a baseline for following *in vivo* experiments.

In vivo studies

The effects of NAC treatment have been tested almost exclusively on silica-injured rats or mice. Rats exposed to an intratracheal instillation of silica particles were treated with NAC at a dose of 500 mg/kg orally every day for 7 days before and up to 28 days after the silica administration. The treatment with NAC reduced the fibrotic score, decreased concentrations

of hydroxyproline, a marker of collagen production, and malondialdehyde (MDA), a marker of oxidative stress, and prevented silica-induced increases in TNFα, IL-8 and high-sensitivity C-reactive protein in the bronchoalveolar lavage fluid (BALF) and serum (48).

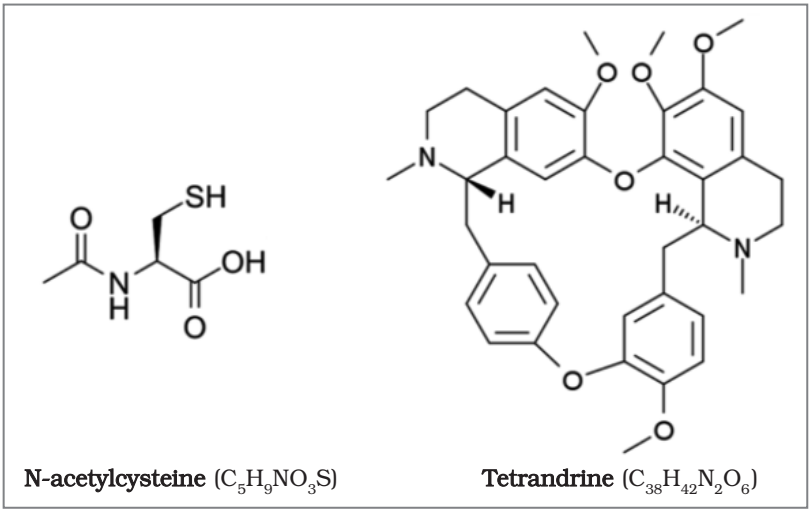
In other rat model of silicosis, the delivery of NAC by gavage at a dose of 600 mg given since the silica instillation for up to 28 days, led to lighter histopathological changes in the lung with no cell nodules or silicotic nodules formation compared to the non-treated group. In addition, NAC reduced the contents of mitochondrial apoptosis pathway-related proteins cytochrome C, caspases-3 and -9, declined the contents of fibrosis markers procollagens-I and -III, decreased the intracellular content of ROS and prevented a decrease in mitochondrial transmembrane potential (MTP) (49).

In mice, NAC was given by gavage every day at three different doses: a low dose (1.73 mg/20 g), a moderate dose (3.46 mg/20 g), or at a high dose (5.19 mg/20 g), respectively, for 24 h or 1, 2, 3, 4, or 5 months to observe the effects of NAC on silica-induced inflammation and fibrosis. NAC reduced a generation of pro-inflammatory cytokines in BALF and decreased a level of lipoperoxidation marker MDA, with a stronger effect observed for moderate and high doses of NAC. On the other hand, NAC markedly enhanced the activities of antioxidant markers glutathione peroxidase and superoxide dismutase, and elevated the total antioxidant capacity. NAC treatment also down-regulated the oxidising enzymes NADPH oxidase 2, inducible nitric oxide synthase, superoxide dismutase 2, and xanthine oxidase. Moreover, NAC prevented a pulmonary injury including a fibrogenic response with a deposition of collagen. NAC also partially reversed an epithelial-mesenchymal transition (EMT) and a mesenchymal cell mobility, as confirmed by an increased expression of E-cadherin, which is down-regulated in fibrosis, decreased an expression of vimentin, a marker of mesenchymally-derived cells undergoing EMT, and lowered an expression of cytochrome C, which may be released from mitochondrial membrane in an injury and serves as a pro-inflammatory and pro-fibrotic factor (17).

We are aware of serious limitations which arise from the use of animal models of silicosis. The effects of the treatment may be influenced by inter-species differences (rat *vs* human, mouse *vs* human etc.) in the response to silica as well as to the given therapy because of the differences in immune responses, the specifics of inflammatory and metabolic pathways, etc. Therefore, the dose of the given treatment cannot be transfered directly from the animal model to humans. In addition, in animal models, silica is usually instilled into the trachea of animals homogenously to both lung lobes by a syringe, thus, also the mode of the lung affection is different from cumulative targeting the lung by inhalation in humans. An additional limitation is caused by the use of healthy young animals without any other concomittant diseases, which is a different situation from human disorder where serious lung silicosis is usually detected in older men where the lung silicosis is often associated with other chronic diseases, smoking, etc. Nevertheless, the use of animal models is the best way how to test at least in the laboratory conditions a potential of new treatment approaches before their introduction in the clinical studies. Pre-clinical testing reduces potential risks and represents a valuable pre-clinical base for clinical studies.

Clinical studies

After the publication of *in vivo* study where a combined therapy with NAC and tetrandrine in silicotic rats was more effective in anti-inflammatory, antioxidant and anti-fibrotic action than the treatments given separately (50), this combined treatment has started to be used also in the clinical studies (51-53). Tetrandrine isolated from the root of *Stephania tetrandra S. Moore* belongs to a group of bisbenzylisoquinoline alkaloids. Tetrandrine is used in traditional Chinese medicine because of its multiple anti-inflammatory effects including the reduction of ROS production, enhanced autophagic flux, the reversal of multi-drug resistance, influencing caspase pathway, cell cycle arrest and by modification of calcium channels. In silicosis, tetrandrine may alleviate pulmonary fibrosis and inflammation *via* reducing the level of type I and III collagen mRNA and collagen deposition in the lung (54, 55).



N-acetylcysteine ($C_5H_9NO_3S$) **Tetrandrine** ($C_{38}H_{42}N_2O_6$)

Fig. 1. Chemical structures of N-acetylcysteine and tetrandrine

In a group of 88 patients with silicosis, tetrandrine at a dose of 60 mg–100 mg/time was given 3 times a day for 6 days and then stopped for 1 day, while a course of tetrandrine treatment lasted for 3 months. This treatment was combined with a delivery of NAC effervescent tablets of 600 mg at a dose of 1 tablet/time, 1–2 times/day, which lasted for 8 months. The combined treatment decreased a respiratory rate, enhanced forced vital capacity (FVC) and first second forced expiratory volume (FEV1), and decreased plasma levels of TNFα and IL-6 compared to the control group (51).

Similar positive results of the combined NAC+tetrandrine treatment were observed in the study by Guo et al. (52) where the treatment was given to 132 patients with lung silicosis in the folllowing regime: NAC effervescent tablets 600 mg/time, 2 times daily; tetrandrine tablets 100 mg/time, 2 times daily; while the drug delivery was stopped after 6 days for 1 day; and the treatment was given in 4 courses for 8 months. The treatment combination improved the pulmonary function tests, an exercise tolerance of patients demonstrated by a 6 min walk test, and an occurance of symptoms such as chest tightness, chest pain, cough, or sputum production (52).

In a group of 79 patients with silicosis, a combined treatment was given as following: NAC effervescent tablets of 600 mg were administered twice a day, with 12 days long duration of the treatment course. The patients received one course per month in the first two months, then one course every 2 months, and the patients received 4 courses in total. Tetrandrine tablets of 60–100 mg were given three times a day for 6 days a week. One course of the treatment lasted 3 months, then stopped for 1 month, and subsequently continued in the second course for 3 months. This design of the treatment improved the rates of respiratory distress, chest pain, and dyspnea compared to the control group and increased an exercise tolerance expressed by a 6-min walk test. In addition, NAC+tetrandrine treatment reduced the plasma levels of TGF-β1, a potent fibrogenic and pro-inflammatory factor, and decreased matrix metalloproteinase (MMP)-7, a key factor in fibrosis which degrades cytoplasmic matrix components (53).

CONCLUSIONS

Overexpression of ROS is a fundamental pathomechanism responsible for origin and chronic persistence of changes in pulmonary silicosis. Recent studies have demonstrated that the administration of antioxidants, e.g. of NAC, may not only decrease the oxidative

stress but may also alleviate the lung inflammation and fibrosis. In additon, the results from animal studies demonstrating the benefits of preventive use of NAC indicate that regarding a long-term development of lung silicosis the preventive use of NAC or other antioxidants may mitigate the extent of silica-induced changes and, therefore, the long-term use of antioxidants in silicosis-predisposed occupations is one of the treatment possibilities. Nevertheless, we are aware that additional clinical studies are necessary to evaluate the positive but also the possible adverse effects before any recommendations about the use of NAC for the treatment of silicosis could be made. However, the first clinical studies from China indicate that the use of NAC may be one of valuable approaches for diminishing the lung injury and improving the prognosis of patients with pulmonary silicosis.

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RE-EMPHASIZING THE ROLES OF GENERAL MEDICAL AND DENTAL PRACTITIONERS REGARDING ORAL CANCER ERADICATION IN NIGERIA

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Abstract

The burden of oral cancer in Nigeria is largely under-reported. The available data on oral cancer etiology/risk factors, clinical features, disease burden, and literacy rate in Nigeria points towards a possible explosion in prevalence in the near future, which poses a serious public health concern. The general medical and dental practitioners (GMDPs) in Nigeria can salvage this looming problem through appropriate public health and clinical interventions. This narrative review article re-emphasizes the key roles of GMDPs towards oral cancer eradication in Nigeria. It also discusses oral cancer case definition, etiology, risk factors, and the epidemiological burden in the Nigerian context.

Keywords: Oral cancer, eradication, general, physicians, dentists, Nigeria

KEY MESSAGES

The burden of oral cancer disease and its risk factors in Nigeria is of a serious public health concern. The general medical and dental practitioners (GMDPs) in Nigeria can help salvage this looming problem through oral cancer education, screening, and prompt referrals.

INTRODUCTION

Oral cancer, in simple terms, is a group of malignancies that occur in the oral cavity and the oropharynx. Globally, oral cancer is the sixteenth commonest type of cancer and the fifteenth leading cause of cancer-related deaths worldwide. They are also the most common form of cancers affecting the head and neck region [1,2].

In both developing and developed nations, oral cancer is a disease of public health importance. Oral cancer has the lowest five-year survival rate among major cancers (including breast and colon cancers) with two-thirds of cases occurring in the developing nations majorly due to poverty, illiteracy, risky cultural beliefs, etc. [3]. Oral cancer occurs around the fifth decade of life and its occurrence is linked with some etiological/risk factors including tobacco and alcohol use, human papillomavirus (HPV) infections, background genetic susceptibility, environmental factors (such as excessive exposure to sunlight, industrial pollutions, etc.), poor nutritional states, amongst others [4].

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There is a persistently rising prevalence of oral cancer and its risk factors in Nigeria; however, only very little has been done towards oral cancer eradication in Nigeria, especially in the area of oral cancer education, screening, detection, and early management [5-12]. With the current rising trend of oral cancer risk factors in Nigeria, the need for routine oral cancer education, screening, detection, and early management cannot be overemphasized. In order to achieve an oral cancer-free status in Nigeria, so much effort needs to be invested towards these areas. The entire healthcare workforce in Nigeria has a collective role to play towards achieving an oral cancer-free status in Nigeria. However, for the scope of this study, we will limit our discussion to the roles of general medical and dental practitioners (GMDPs) towards the achievement of this desirable status.

Our study's scope is focused on the GMDPs because of our relatively deeper understanding of general medical and dental practice in Nigeria, compared to other clinical practice types. The GMDPs constitute a huge population of first-line givers of preventive oral and general healthcare services. Specifically, the primary jurisdiction of the general dental practitioners (GDPs) is the oro-facial region. Basically, oral health education and counseling, oro-facial examination, oro-facial disease detection, proper documentation, reporting and referral are routine procedures for GDPs. On the other hand, the conduct of general health education and counseling, general examination, systemic disease detection, proper documentation, reporting and referral are routine procedures for GMPs.

However, research has shown that most GMDPs in Nigeria have at least a basic knowledge of oral cancer (including its risk factors, common sites of occurrence, and clinical features) [13,14]. The GMDPs constitute the majority of the medical doctors and dentists in Nigeria. Also, the workforce size of GMDPs is bigger than that of the dental and medical specialists by far. Based on the afore-stated, the GMDPs basically have very huge roles to play when it comes to oral cancer eradication in Nigeria. However, in Nigeria, due to the very high patient-GMDP ratio in Nigeria, many GMDPs practicing in Nigeria are often overworked. The heavy burden of the clinical workloads on the heads of GMDPs in Nigeria often times limits their opportunity to deliver a very comprehensive healthcare service to their patients; this has resulted into GMDPs having inadequate time or poor attitude towards in-depth evaluation and education of their patients [13,14]. Unfortunately, this has invariably reduced patients' opportunity for holistic evaluation of their general and oral health status.

The need for proper evaluation and education of all patients by GMDPs on oral cancer cannot be overemphasized, more especially in Nigeria – a country with the rising burden of oral cancer risk factors. Hence, this study aims to give an overview about oral cancer case definition, its etiology, its risk factors, and as well the epidemiological burden in the Nigerian context. Importantly, this article aims to re-emphasize the highly crucial roles of GMDPs towards eradicating oral cancer in Nigeria.

METHODS

This study was a narrative review of relevant literature written on the topic of study. In our sourcing of literature, we used the following research databases: Google Scholar, PubMed, ResearchGate, SCOPUS, CINAHL, PsycINFO, and AJOL. Relevant information was retrieved from the literature obtained for this review.

CASE DEFINITION AND ETIOLOGICAL / RISK FACTORS OF ORAL CANCER

Case Definition

The majority of oral cancers are classified histologically as oral squamous cell carcinoma (OSCC); this is because most oral cancers develop from the squamous cells – a predominant cell group – in the oral cavity [15].

Early oral cancer lesions may go undetected due to the lack of symptoms and detectable signs and this contributes to the reasons for many late presentations by patients. Therefore, clinicians should look out for potential signs of oral cancers during routine oral examinations as they can easily be missed. These early oral cancer signs include alterations in the oral mucosa in the form of rough, red or red-white lesions, induration, fixation, non-healing extraction sockets, etc. [16] which may develop into a mass with associated ulcerations, lymph node enlargement, dysphagia, halitosis, bleeding, loss of appetite, and weight loss [17]. Thus, the examination of the oral cavity with thorough lymph node evaluation is of great importance.

Etiological / Risk Factors

The etiology of oral cancer is complex and can be described based on the various predisposing factors including tobacco use, alcohol use, exposure to human papillomavirus (HPV) through sexual activities, nutritional deficiency/poverty, industrial pollution, background genetic predisposition, sunlight exposure, etc. [19]. These risk factors vary based on ethnicity, race, environmental factors, cultural beliefs, socioeconomic factors (including access to health care, financial capacity, etc.), oral cancer knowledge, etc.

Tobacco Use: Tobacco use (either in smoked form [e.g. cigarette, cigar, pipe, etc.] or smokeless form [e.g. tobacco leaf, snuff, etc.]) alone is an oral cancer risk factor [19]. A mixture of tobacco with leaves and barks like kola nut, Areca nut (zupari), khat/miraa, toombak, betel quids, etc. are also oral cancer risk factors [20].

Many of the potential carcinogens in tobacco and their various products come in contact with the oral mucosa and permeate the oral tissues inducing a change in the deoxyribonucleic acid (DNA) of the cells thereby causing accumulation of damaged DNA in the cells. This damage in cellular DNA has been implicated in the pathogenesis of oral cancer [21] through the mutation of p53 gene, mutation of heterozygosity (H-RAS), and amplification of RAS oncogene leading to abnormal and uncontrollable cell division [22].

Kola Nut Consumption: The habitual chewing of kola nut has been described as an important risk factor for oral cancer especially in the Northwest and Northeast zones of Nigeria [23]. Kola nut chewing has been found to induce palatal keratinization and also have a co-carcinogenic potential when taken with tobacco [24]. It contains tannins that are capable of inducing oral cancer [24]. Ochratoxin A is also a toxic metabolite produced in kola nuts which is both carcinogenic and genetoxic [25].

Alcohol Consumption: Alcohol consumption plays a major role in the etiology of oral cancer. It works synergistically with tobacco to increase the risk of oral cancer by acting as a solvent to assist in the penetration of carcinogens in tobacco into the oral mucosal tissues. The additives in most alcoholic beverages as well as the metabolites of alcohol (acetaldehyde) also have direct carcinogenic effects by altering the p53 gene and RAS oncogene through the actions of the free radicals they generate [26,27]. Chronic alcohol consumption also reduces liver's ability to detoxify potential carcinogens thereby causing susceptibility to neoplasms including oral cancer [28].

Human Papillomavirus (HPV) Infection: Human papillomavirus (HPV) infections are primary initiators of cancer of the uterine cervix, anus, and the vagina, but a number of cases (about 50%) of oral and oropharyngeal squamous cell carcinomas have been linked with HPV infections even though the causative mechanism is still unclear [29]. Reports suggest that functional dysregulation of the tumor suppressor genes (p53 and pRb) by the insertion of the viral DNA fragments (early genes E6 and E7, respectively) of carcinogenic HPV leads to uncontrolled DNA replication and an increased risk of neoplastic transformation. The

HPV-16 and 18 subtypes have both been implicated in the pathogenesis of oral cancer with the HPV-18 subtype far less (14%) commonly associated with it [30].

Nutritional Deficiency: Nutritional deficiency is a key predisposing factor to oral cancer [31]. Fruits and vegetables are foods rich in Vitamins A, C, and E – antioxidants. These antioxidants help to remove free radicals capable of causing cellular destruction [32]. Iron is also an essential micronutrient for the overall integrity of the epithelium of the digestive tract including the oral cavity which becomes atrophic during its deficiency [33]. A study reveals that despite the atrophic changes due to iron deficiency, there is an increased cell proliferation and epithelial turnover [34]. This proliferation can be linked to the etiology of cancer development. In fact, as far back as 1919, Paterson and Kelly have previously and independently linked nutritional deficiency with the development of cancer; they a described the Paterson-Kelly syndrome – a syndrome marked by iron deficiency, chronic anemia with different vitamin deficiencies [35,36]; also, this syndrome had been implicated in the development of pharyngeal and oral cancers [36,37].

Socioeconomic Status: There is no doubt that socioeconomic status has been linked with the prevalence of oral cancer worldwide even though some studies had yielded so many conflicting results [38]. Studies around the world and in Nigeria have revealed a decreased risk of oral cancers among individuals with high socioeconomic status based on increased level of education [38] and their occupation [39]. It is believed that those with high socioeconomic status have access to quality health care facilities and health awareness which are important in improving their health seeking behavior [40]; also, they undergo routine dental/oral checks which go a long way in facilitating early diagnosis of lesions including oral cancers [41,42].

Cultural Beliefs: Poor cultural beliefs contribute to poor prognosis of oral cancers. Some people believe that cancer does not respond to orthodox treatments [43]; hence, they patronize traditional healers and herbalists who live within the local community. As a matter of fact, traditional healing is enshrined in the culture of the people, especially in Nigeria and many other climes. This makes hospitals therefore become a place of last resort where people with such cultural practice present at advanced stages of oral cancer leading to poor clinical outcomes and survival rate [43].

Genetic Factors: Few genetic factors are considered in the etiology of oral cancer. The alteration in the genetic makeup of cells either spontaneously or induced by mutagens has been linked with the tumogenesis of oral cancer [44]. Social factors like chewing of betel quids, smoking, actions of viruses, irradiations, or chemicals may lead to a segregation of chromosomes in the genes of cells. There may also be mutation of the H-RAS and K-RAS which are oncogenes leading to an upregulation of these oncogenic genes to predispose to oral squamous cell carcinoma – an oral cancer type [44,45]. This however shows the influence of the environmental factors on the genetic makeup.

Environmental Factors: Excessive exposure to sunlight through actinic radiation predisposes an individual to oral cancer (especially lip cancer) [46]. The repeated exposure to the ultraviolet rays in sunlight results in atrophy of the exposed aspect of the lower lip which can develop into oral cancer especially along the vermillion border of the lower lip. Hence, this explains the development of farmer's and sailor's lip [47].

Occupational Hazards: Occupational exposure to solvents like pesticides and other chemicals, engine exhausts, textile and leather dusts, etc. may increase the risk of oral cancers [48-52]. This claim is however conflicting; while some studies reported a link between oral cancer and various occupational exposures, some researchers had denied a relationship between them [48-52].

Age and Gender: Generally, oral cancer is associated with advancing age [53]. It is mainly diagnosed in persons who are older than 40 years [54]. However, some studies in Africa found a large proportion of oral cancer cases in persons who are below the age of 40 years [55,56]. Human papillomavirus had been implicated in cases of oral cancer amongst persons below the age of 40 years [57].

In Nigeria, the age of occurrence of oral cancer varies based on reports from different geopolitical zones in Nigeria and it ranges between the 3rd and 6th decades of life [58-60].

Oral cancer has also been reported to be commoner in males than females (1.7:1) but this ratio is getting closer and has narrowed to about 1.3:1 in recent studies [61,62]. Though the reason for the increase in incidence rate among females has not been fully understood; although an increase in the social habits like smoking and alcohol consumption among females have been suggested.

CLINICAL FEATURES OF ORAL CANCER

The diagnosis of oral cancer has been made as far back as the 2500-3000 BC when it was known as an eating ulcer of the gum as contained in Ebers Papyrus' work titled "Treaties on Tumours" [1]. Hence, oral cancer is a disease of the ancient times; unlike the popular belief which describes it as a disease of the modern era [1]. Proper clinical examination goes a long way in the accurate diagnosis of oral cancer. Accurate diagnosis of oral cancer requires an adequate understanding of the clinical features of the disease. There are numerous clinical features associated with oral cancer. Early oral cancer lesions are usually asymptomatic and are incidentally picked up while the advanced stages of the disease are usually symptomatic [63]. Oral cancers may present in a variety of forms, the appearance of all of which need to be familiar to the GMDPs for easy diagnosis.

Below are the clinical features associated with oral cancers, they are:

Non-healing Oral Ulcer

Oral ulcer is the loss or erosion of the delicate lining tissues of the oral cavity (i.e. the mucous membrane). They mostly respond to a regular therapy between 7 to 14 days [64]. However, an ulcer which persists for more than three weeks is one of the most frequent presentations for the early stage of oral cancer and should be biopsied [65,66]. Early lesions are usually painless and diagnosed through incidental finding. They appear as red or white lesions with indurated, rolled or ill-defined thickened margins with lack of surrounding inflammation in relation to the ulcer. The ulcers are mostly found in the tongue, floor of the mouth, gingivae mandibular alveolus, palate, etc. [67]. In fact, all unilateral/localized non-healing ulcers should be examined and investigated for oral cancers [68].Dysplastic lesions on the lateral or ventral surface of the tongue as well as the floor of the mouth may however be suggestive of oral cancer [69]. Importantly, the advanced stage of oral cancer ulcer is associated with pain and it appears as large-sized solitary ulcer with raised borders and indurated margins with necrotic bases [70].

Oral cancer ulcers are persistent even following the exclusion of possible causes [63,64]. They are also non-responsive to any regular therapy and may rather increase in their intensity. GMDPs must clearly differentiate these suspicious lesions from normal reactive oral ulcerations [71].

Dental Pain

Oral cancer is often associated with pain especially at the advanced stage of the disease due to its induction of nerve dysfunction [64]. This mostly makes patient to present at the hospital as it affects their feeding, speech, swallowing, and general social interactions [72]. A tooth associated with oral cancer that is otherwise healthy with no evidence of pathology may become painful; this occurs in about 28% of oral cancer cases [73].

Tooth Mobility

Although tooth mobility may be caused by various factors like periodontitis, dental trauma, uncontrolled diabetes mellitus, etc.; it can also be seen in oral cancer patients. This may be associated with destruction of the supporting structures of the teeth (periodontium) by the tumour cells [74].

Neck Mass (Lymph node enlargement)

The potential of oral cancer cells to metastasize into the neighboring lymph nodes, especially the cervical lymph nodes has been well documented [75]. Hence, lymphedema is a common clinical finding in these patients [76].

Progressive Swelling in the Mouth

A progressively increasing oral swelling, a common oral cancer symptom, is due to the uncontrolled growth of the oral cancer tissues. These abnormal lumps progressively increase in size and could become ulcerated and erythematous due to a secondary trauma. This lesion may be fungating and exophytic with characteristic ulceration [77].

Bleeding from the Oral Cavity

Bleeding from the oral cavity in oral cancer patients may be due to the primary cancer or a secondary trauma on the abnormal oral cancer tissues [67].

EPIDEMIOLOGICAL BURDEN OF ORAL CANCER AND ITS RISK FACTORS IN NIGERIA

Oral Cancer Data in Nigeria: Status Quo

Oral cancer is one of the leading cancers among Africans, Nigerians inclusive [78]. However, due to inadequate and poorly functioning cancer registries, as well as under-reportage of oral cancer, the burden of oral cancer in Nigeria is still inaccurately depicted in official reports [78]. In fact, scientists have affirmed that the number of cases of oral cancer seen in Nigerian hospitals is far lesser than the number of people living with oral cancer [78]. Obviously, oral cancer disease burden is an issue that requires serious public health intervention.

Prevalence of Oral Cancer in Nigeria

The actual national prevalence of oral cancer In Nigeria is unknown; however, according to clinical epidemiological studies, about 1.2-2.7% of all malignant lesions are oral cancers [79,80].

Pattern of Oral Cancer in Nigeria

Oral cancer lesion may involve the lip, tongue, floor of the mouth, retro-molar area, gingivae, buccal mucosa, palate, etc. The tongue and floor of the mouth are the most common sites of occurrence in the developed countries while studies in the developing nations have showed different sites of occurrence. In Nigeria, the maxillary antrum (14.2–36.7%), mandibular alveolus (17.06–23%), palate (12–16.5%), tongue (5.2–12%), had been recorded as the most common sites of the lesion while the floor of the mouth (4.7%) and buccal mucosa (5.2%) are the least common sites [18, 61, 81–83].

Review of Oral Cancer Risk Factors in Nigeria

A research had shown that tobacco users are three times more at risk of oral cancer than non-tobacco users [84]. This makes tobacco use in any form a significant risk factor for the development of oral cancer [85]. However, reports from Nigeria had only shown a low prevalence of tobacco use among Nigerian oral cancer patients. These reports favored poverty, nutritional deficiency, low socioeconomic status, chronic malaria, etc. as the significant predisposing factors to oral cancer among Nigerians [79]. This may anecdotally be linked with

a withdrawal of sensitive social history such as tobacco and alcohol use by patients during hospital visits, as many of the patients who denied the use of tobacco may actually be consuming them or had just stopped consuming them.

The prevalence of HPV-induced oropharyngeal cancers is increasing in USA and across Europe (60% and 31%, respectively) with oral cancer recording just 3%; this is strongly related to sexual habits and experience [86]. The risk of HPV-induced oral cancer increases with the number of sexual partners, increased oral/genital contacts, history of genital warts, and an early age of sexual debut [87]. However, in Nigeria, research into the HPV-induced oral cancer is quite limited. The cultural sensitivity among the people may have contributed to the difficulty in obtaining accurate data on the various sexual practices that could be linked with HPV-induced oral cancer. A multi-center study in Nigeria also showed that most oral cancer cases were HPV negative [87,88]. Hence, HPV may not be a significant predisposing factor for oral squamous cell carcinoma in Nigeria.

There is a common saying in Nigeria that kola nut is produced in the West by Yorubas, consumed in the North by Hausas, and worshipped in the East by the Igbos [89]. This underscores the fact that the northern region of Nigeria consume kola nut in a large quantity when compared to the other regions in Nigeria. The habitual chewing of kola nut has been described as an important risk factor for oral cancer especially in the northwestern and northeastern zones of Nigeria [23]. This suggests that the rate of kola nut-induced oral cancer will be higher in the northern parts of Nigeria than the Southern parts.

Poor cultural belief among some Nigerian population groups is also an oral cancer risk factor. For example, some people in the northern part of Nigeria believe that cancer does not respond to Orthodox treatment. Hence, they patronize traditional healers and herbalists (known as boka) who live within the community [43]. Similarly, in the southwestern part of Nigeria, many people believe that oral cancer is caused by various spiritual attacks [90]. Most patients however use herbal or spiritual remedies and only present at the hospital when the expected cure is not achieved. This leads to late presentations and also poor prognosis.

The northern part of Nigeria is said to be the hottest part of the country as mean monthly maximum temperature varies between 29 and 40 degree Celsius [91]. People in this part mainly engage in outdoor jobs like farming and are exposed to intense sunlight for several hours on a daily basis. This poses the risk of developing lower lip cancers which are three times more common in males than females [92]. Most of the men engage in outdoor occupation and majority of their wives take care of the children at home with little exposure to sunlight.

The prevalence of other oral cancer risk factors like tobacco use, alcohol drinking, and oral sex had been fairly studied in Nigeria. Nigerian studies had reported that at least one out of every ten to twenty Nigerians, particularly the young people, either smoke tobacco, drink alcohol, or engage in oral sex [93-95]. In times past, the prevalence rates of these behaviors were lower; however, due to ongoing Western civilizations, these rates have increased over the years [59,93-95]. This shows that oral cancer risk factors in Nigeria are issues of a serious public health concern

The above-described picture on the oral cancer risk factor burden predicts that Nigeria will most probably have an explosion in the rate of oral cancer prevalence in the future, if nothing is done towards curbing the prevalence of oral cancer etiological/risk factors among its populations.

WHAT ARE THE ROLES OF GMDPs TOWARDS ORAL CANCER ERADICATION IN NIGERIA?

The GMDPs have significant roles to play towards oral cancer eradication in Nigeria. These roles are multifaceted and they include both clinical and non-clinical interventions. Previous studies have shown that the GMDPs have basic knowledge of the risk factors, common sites of occurrence, and clinical features of oral cancer [13,14]; therefore, GMDPs are up to the task.

Below are the roles of GMDPs regarding oral cancer eradication in Nigeria:

Public Enlightenment on the Major risk Factors and Clinical Features of Oral Cancer: Low public awareness of the risk factors of oral cancer as well as its presentations at its early stage have been identified as the factors contributing to late presentations and subsequent poor survival rate of oral cancer cases recorded in Nigeria [5-12]. Public awareness on oral cancer is highly important regarding its eradication in Nigeria. The ability of lay people to identify oral cancer risk factors and early symptoms will aid early and prompt clinical intervention.

Unfortunately, many health-related media-based information (especially those on social media) are misleading and encouraging behavior that make people prone to oral cancer [96]. The GMDPs can help promote proper public education on oral cancer through the use of community-based medical outreaches, patient education in clinics, print media, television and radio broadcasts, social media, etc. The adoption of this public health education strategy can bring about a change in the behavior and social lifestyle of people engaging in behavior that predisposes humans to oral cancer.

Early Detection and Diagnosis of Oral Cancer Lesions: It has been established that early diagnosis and treatment is associated with decreased mortality and better prognosis [64,72]. Routine screening for early lesions of oral cancer especially in the high-risk (i.e. those persons with oral cancer risk factors) have been shown to be highly beneficial. Routine oral cancer screening, either individual or population-based screening, has been found to significantly increase oral cancer prevention rate, improve treatment outcomes, and reduce mortality rate among oral cancer high risk groups in India [97]; therefore, there is high hope that the current oral cancer burden in Nigeria can be reduced to the barest minimum if GMDPs in Nigeria can intensify their engagements in community-based and clinic-based oral cancer screening programs.

Non-invasive diagnostic tools can be used by the GMDPs for early diagnosis of oral cancer lesions. The use of toluidine blue staining on suspicious oral mucosa changes is a good oral cancer diagnostic option which can be adopted by GMDPs in Nigeria. The technique is quite simple and less expensive for a low-resource setting like Nigeria. The technique is highly sensitive; however, less specific because of high false positive results [98]. Other non-invasive techniques like autofluorescence, chemiluminescence can also be used [99]. Biopsy of oral cancer lesions – the gold standard for the diagnosis of oral cancer – can also be done (especially by general dental practitioners).

Prompt Referral of newly Diagnosed Cases of Oral Cancer: Prompt referral by GMDPs to oral cancer specialist clinics following their diagnosis of oral cancer in general care patients is very important. Since oral cancer treatment outcome largely depends on the stage at which clinical intervention is done, then prompt treatment of the disease is non-negotiable [7,78]. Not all secondary healthcare facilities in Nigeria have equipment and specialists needed for oral cancer treatment. In fact, only very few healthcare centers in Nigeria have the capacity to treat oral cancer patients. Hence, all these facilities need to be known by GMDPs in Nigeria; also, prompt patient referrals should be made by GMDPs to these centers regarding newly detected oral cancer cases. By so-doing, the burden of oral cancer in Nigeria will reduce significantly.

Based on the above, we recommend that the stake holders involved in oral cancer eradication in Nigeria, under the leadership of the Federal Ministry of Health of Nigeria, should develop and produce a directory of medical centers and specialists responsible for advanced oral cancer care in Nigeria. Copies of this directory can be shared among GMDPs in Nigeria in order to ease their task in future referrals of oral cancer cases in Nigeria.

Behavior Cessation Counseling: Some oral cancer risk factors, such as tobacco use, oral sex, and alcohol use are addictive behavior. These addictive behaviors can be difficult to quit without the help of clinical intervention. There are different clinical intervention strategies that can be adopted in the addictive behavior cessation treatment; however, the most effective of them is cessation counseling. However, behavior cessation counseling programs in Nigeria is not yet well-established unlike in the Western countries. In fact, based on the authors' experience, many hospitals in Nigeria do not have such programs in place for patients with addictions such as tobacco addiction, sex addiction, and alcohol addiction; this may be because quite a number of GMDPs in Nigeria lack adequate behavior cessation counseling knowledge and skills [100]. This shows that many GMDPs most probably need more training behavior cessation counseling.

Based on the above, it is highly recommended that all GMDPs in Nigeria receive adequately trained on behavior cessation counseling techniques. If the GMDPs acquire these skills, they will be placed in a stronger position to successfully assist their patients in quitting addictive behavior that can make them at risk of developing oral cancer disease.

Oral Cancer Prevention Advocacy: Advocacy on oral cancer prevention goes a very long way in the journey towards oral cancer eradication in Nigeria. The GMDPs are doctors; doctors are highly respected and influential persons in the Nigerian society. Importantly, the GMDPs form a large proportion of the population of doctors in Nigeria; hence, they have a very strong public voice when it comes to public health advocacy. Over the years, the GMDPs in Nigeria have successfully played very strong roles in many infectious disease eradication advocacy programs. However, only very little advocacy efforts had been channelled by GMDPs towards oral cancer eradication in Nigeria.

Oral cancer is a leading killer disease which appears to be neglected in Nigeria. Unfortunately, oral cancer is still yet to be widely seen as a public health threat in Nigeria. The GMDPS, having a strong voice in the Nigerian society, urgently need to put in more efforts towards oral cancer prevention advocacy in the country. Some of the policy areas that GMDPs can advocate for are "improvement in tobacco and alcohol regulation policies", "free oral cancer screening and diagnosis", "provision of free national HPV vaccination programs", "provision of free oral cancer care", and more. If the GMDPs can push for the implementation of progressive and workable public health policies in favor of oral cancer prevention (especially in those afore-mentioned policy areas), the burden of oral cancer in Nigeria will be brought to the barest minimum.

CONCLUSION

The burden of oral cancer in Nigeria is largely under-reported. However, the existing data on oral cancer disease burden, risk factors, and literacy rate in Nigeria still draws serious public health concerns, as these data are pointing towards possible explosion in oral cancer prevalence in the nearest future. The GMDPs in Nigeria can help salvage this looming problem through their public health and clinical interventions.

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OBTURATION OF ROOT CANALS BY VERTICAL CONDENSATION OF GUTTA-PERCHA – BENEFITS AND PITFALLS

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Abstract

Vertical condensation of gutta-percha is one of the frequently used techniques of hermetic and three-dimensional obturation of root canal system which is one of the primary goals of endodontic tooth treatment. Techniques for filling root canals have been described since ancient Egypt and have undergone dynamic development in recent decades. The aim of the article is to analyze the technique of obturation of root canals using vertical condensation of gutta-percha and to point out its benefits and pitfalls.

The poor-quality treatment of the tooth deteriorates its prognosis, function, and long-term survival in the oral cavity; thus, the hermetic obturation of the root canals is one of the most important pillars of the complex tooth treatment. Obturation of the root canals by vertical condensation of warm gutta-percha is nowadays considered in the correct indications as one of the most commonly used techniques in the excellent dental practices. Even though it is quite technologically challenging and time-consuming it enables to reach high level of predictability and clinical success. Currently, the obturation technique based on master gutta-percha cone combined with the calcium-silicate based sealer is emerging. However, long term results of clinical studies and follow-up are needed to make a significant improvement in the area of endodontics.

Keywords: endodontics, vertical condensation, gutta-percha, root canal obturation

INTRODUCTION

The dental pulp may be irritated by various pathological processes with bacterial pathogens from progressive dental caries, periodontal lesions, or micro/macro trauma of the tooth being most common. Disruption of physiological defense mechanisms leads to inflammation or necrosis of the dental pulp with possible harm to the periapical area and potential development of abscess or phlegmon (Farges et al., 2015). According to the prognosis of the tooth and the overall condition of the patient the dentist decides between the endodontic and extraction therapy (Hargreaves and Berman, 2016).

The methods of root canals obturation has undergone significant development. The root canals were already filled by ancient Chinese or Egyptians. The concept and understanding of endodontic treatment changed throughout the history and is changing dynamically nowadays as well. In the near past, diverse techniques and materials have been used for obturation. In Slovakia, the technique of conventional root canal filling with a central gutta-percha cone was preferred. Recently, in accordance with the introduction of modern devices and materials, obturation using a central gutta-percha cone in combination with the calcium si-

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licate sealer or complete obturation of the canals with calcium silicate materials has come to the fore (Zare et al., 2021). The technique of obturating root canals by vertical condensation of gutta-percha is one of the leading techniques and has proven to be the most suitable in certain clinical indications.

The correct choice of the obturation technique is crucial. A variety of available materials as well as instrumentation systems make the decision difficult. Moreover, the root systems may have complicated anatomy, which makes the right choice even more challenging. Vertical condensation of gutta-percha or its combination with other techniques represents the optimal option in most clinical situations with a potential of high-quality treatment result.

Despite the fact that we can predictably make a long-lasting root filling nowadays, it is necessary to realize that the best "filling" of the root canal is its healthy dental pulp. For this reason, it has to be always preserved and its iatrogenic damage must be avoided.

Obturation of root canals – equipment and materials

Endodontic devices enabling vertical condensation of gutta-percha have appeared for the first time in the 1960s as a novelty representing an efficient way of obturating the root canals. Over the past, this technology has undergone significant development, improving its properties and significantly eliminating the negatives and risks it entails.

A significant milestone in the development was the introduction of the "backfill" tool which allows the exact and fast placement of the plastic gutta-percha only by pressing and holding a button. Combining the use of a heatplugger (also known as a "DownPack") and a backfill, these devices represent a significant leap in technology and have quickly become used by dentists all around the world (Fig.1) (Perry et al., 2013).

Gutta-percha is an inert material with a relatively good biocompatibility and cytotoxic properties described in literature are attributed to the zinc oxide it contains. As gutta-percha cones have a different composition, their toxicity is also different. However, it is still one of the least cytotoxic materials of its kind available on the market. Unlike most sealer mate-

Fig.1 Equipment and materials. Gutta-percha cones, paper points, WaveOne Gold endodontic files, AH Plus sealer (Dentsply Sirona) and Elements Free (SybronEndo). (Source: author)

rials, gutta-percha is non-resorbable. Its extrusion behind the apex of the tooth is in most cases associated with postoperative complications.

Gutta-percha is soluble in organic solvent which are used to remove it from the root canals during re-endodontic treatment. Effective gutta-percha solvents include e.g. chloroform or eucalyptol (Dotto et al., 2021). It does not adhere to the dentin of the root system and, therefore, all filling techniques using gutta-percha cones require their combination with sealer material.

In dentistry, there are several forms of available gutta-percha but for the needs of vertical condensation it is only necessary to characterize conventional gutta-percha cones and thermoplastic gutta-percha in the form intended for injection (Fig. 1). This form of gutta-percha is produced as pellets which are introduced into a heating system (Obtura III - Obtura) or as prepared cannulas (ElementsTM, Free-Kerr). The injection of a thermoplastic gutta-percha itself is a separate technique, but its use – the name of the "backfill" technique in combination with a central gutta-percha cone – is the basis of the gutta-percha vertical condensation technique.

Comparison of individual techniques of root canal obturation

The correct choice of the obturation technique with regard to the peculiarities of the treated tooth is very important. At the same time, the dentist´s skills and experience as well as the use of modern equipment such as magnifying glasses or operating microscope play a role. In addition to the technique mentioned herein other frequently used methods include the obturation technique of lateral condensation of cold gutta-percha, the technique of applying gutta-percha using a carrier, and filling the root canal in its entirety with calcium silicate materials (e.g., MTA – mineral trioxide aggregate) (Vadachkoria et al., 2019).

Post-endodontic treatment, whether direct or indirect filling or crown, isolates the root system with filling from the environment of the oral cavity. In the event of failure of this barrier, the root filling is exposed to saliva and bacteria.

The root system is considerably complicated and often asymmetric. It may complicate the achievement of a high-quality three-dimensional hermetic seal. In each of the filling techniques tested, a leakage of different extent was demonstrated between the root filling and the canal wall. The leakage rate is related to the resistance of the root filling and insufficient isolation of post-endodontic treatment.

The leakage of root fillings made by vertical condensation of gutta-percha, lateral condensation of cold gutta-percha, and Thermafill technique was evaluated in seventy extracted single-rooted teeth which were decapitated at the cementoenamel junction (Gilbert et al., 2001). Following the extraction, the teeth were stored for 90 days in 100% humidity and after this period the penetration depth of Proteus vulgaris and methylene blue along the fill was monitored over time. Proteus vulgaris was chosen because of its similar size to endodontic pathogens and ease of cultivation. In contrast to previous studies with "India Ink" dye the authors used methylene blue the molecules of which are of a size comparable to endodontic pathogens. The methylene blue leakage was evaluated using the stereomicroscopic pictures at 6x magnification of cleared sample teeth and their examination. The leakage was evaluated and measured with a ruler (0,5 increments) by two independent examiners according to a specific scoring system (Gilbert et al., 2001).

The most perfect seal among the three techniques was achieved with the gutta-percha vertical condensation technique, followed by the Thermafill technique. The most significant leakage was found in the cold gutta-percha lateral condensation technique. As leakage has been reported with each of the technique, it is appropriate to consider the need for root canal re-treatment in root filling exposed to the oral environment (Mathur et al., 2015).

The anatomy of the root system is complex and may be even more complicated by various resorptive pathological processes. The lacuna formed by the process of internal resorption

represents an extreme asymmetry in the root canal. It creates a taper that can be problematic to fill with incorrectly chosen root fill technique. Gencoglu with co-authors (2008) compared several obturation techniques using gutta-percha in filling of an artificially created resorptive lacuna in the middle third of the root canal. They evaluated the degree of filling at the widest point of the lacuna at the horizontal section through the canal and the ratio of sealer material in the root filling. Although the study did not compare the technique of vertical condensation of gutta-percha, the advantage of obturation of root canals by gutta-percha heated and condensed in the root canal in a given anatomical situation was clearly demonstrated. Cold gutta-percha obstruction and Thermafill techniques have proven unsatisfactory.

The three-dimensional obturation of the roots is preceded by its disinfection and mechanical-chemical preparation in order to simplify the root system and by chemical preparation of lateral ramifications and dentinal tubules. Chemical-mechanical preparation and disinfection is very important, but no less is their hermetic obturation. In in vitro study the filling of the lateral ramifications by the method of lateral and vertical condensation of the gutta-percha were compared.

The authors demonstrated that with lateral condensation it is not possible to obturate the lateral ramifications. Vertical condensation enables it, especially in the coronary and middle third of the root canal. Filling of the lateral ramifications 1 mm from the apex was infrequent (Wolf et al., 2021).

Risk factors of the obturation technique

In the technique of vertical condensation of gutta-percha three main risk factors have been identified. They can lead to a damage of periodontium during treatment and prevent or slow down the healing process of the periapical area. The first one is mainly a vertical condensing pressure which increases the probability of excessive extrusion of the obturating material into the periapical space. The second factor is associated with the condensing pressure as well. It may be a cause of dentinal crack propagation leading to a vertical root fracture when obturating the root canal. The third factor is a relatively high temperature of the tip of the heatplugger in the root canal, which can damage the surrounding structures.

Filling materials extruded into periodontium

As it is a non-resorbable material, the extrusion of a gutta-percha cone poses a risk to the healing of periapex. Any pushing of the gutta-percha into this area should be avoided. In contrast to gutta-percha, there are several opinions on the extrusion of a small amount of sealer material (Meneses et al., 2019). One of the preconditions of successful endodontic treatment is the filling of the root canal in its entire length up to the apical constriction. Pushing of a small amount of sealer material into the periodontium corresponds to the shading in the periapical space visible on the X-ray image and is known as "puff" (Fig. 2).

In the root canal, which has not been obturated and, above all, disinfected up to the apical constriction, microorganisms or necrotic pulp residues may remain and trigger pathological changes.

In the following section, the endodontic sealer AH Plus (Dentsply Sirona) is discussed as it is one of the frequently used sealer materials, especially with the method of vertical condensation of gutta-percha (Ricucci et al., 2016).

Sealer materials with different properties are available on the market. With respect to their interaction with periodontal tissues, the degree of cytotoxicity or biocompatibility, solubility, and irritation of periapical tissues is important. For several sealer materials (e.g. AH Plus, Dentsply) their cytotoxic properties are also mentioned, which, however, are present only during solidification of the material. In this particular case, it is about 48 hours, which is not essential in clinical practice (Ricucci et al., 2016).

Not every extruded sealer material is completely resorbed within four years. Sealer material AH Plus (Dentsply) belongs to the category of frequently used sealers that contain epoxy resin. An X-ray examination revealed a complete resorption of extruded AH Plus material in only 15 % of cases within four years (Ricucci et al., 2016).

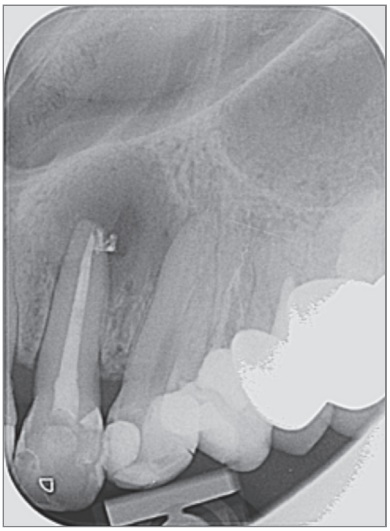

Fig. 2 Postoperative X-ray after obturation by the method of vertical condensation of gutta-percha. The "puff" of the sealer AH Plus (Dentsply Sirona) can be seen on the upper lateral incisor. (Source: author)

Dentinal crack propagation

In different methods of obturation, a certain condensation pressure is applied to the walls of the root canal. If this pressure is too high, cracks formed in the dentin can lead to a vertical fracture of the tooth. In particular, the thickness of the dentin wall gives the resistance of the root to condensing pressures. Therefore, it is an important factor that also has to be taken into the account when selecting the technique and performing the obturation. A suitable way to prevent vertical root fractures in endodontic treatment is a non-aggressive root canal preparation and an adequate condensation pressure in obturation (Chai and Tamse, 2018).

When comparing methods of vertical condensation, lateral condensation, and injection gutta-percha obturations based on the comparison of micro CBCT images it was found that the highest propagation of cracks in the dentin was with lateral condensation of gutta-percha (Chellapilla et al., 2021).

Influence of temperature on periodontium

The tip of a heatplugger (e.g. ElementsTM Free; Kerr) develops an intraradicular temperature of up to 300 °C. Long exposure to such a high temperature can lead to a necrosis of periodontal cells. The manufacturer's declared temperature of 200 °C is developed only on the tip of the heatplugger. It is preceded by a short discharge of 300 °C, which accelerates the heating of the tip. The tip which is the largest source of the heat is isolated from periodontium by gutta-percha, sealer, or dentin of the root canal. This significantly reduces the amount of heat that acts on the periodontium. Dentin as well as gutta-percha are considered very good thermal insulators. For periodontal tissues, an increase in the temperature of more than 10 °C above the physiological temperature is critical and can lead to a thermal tissue injury (Eriksson and Albrektsson, 1983).

Sweatman and coauthors (2001) tested in vitro the effect of thermoplastic gutta-percha temperature on periodontal temperature. The procedure recommended by the manufacturer

increased the tissue temperature by less than 10 °C in either case. Failure to follow a proper procedure can lead to an increase in temperature in the periodontium and a potential thermal injury (Sweatman et al., 2001).

It is not possible to relate the results of the study to in vivo conditions. E.g., the circulation of blood in the periodontium may be protective as it dampens the effect of the applied temperature on the periodontium (Cen et al., 2018).

CONCLUSIONS

The right choice of the obturation technique does not suffice to reach a predictably successful therapy. The decisive factors that affect the patient´s outcome are the knowledge, skill, and experience of the dentist. Last but not least, endodontic treatment requires plenty of time and the need to focus. All above-mentioned factors serve as preconditions for a successful endodontic therapy

The technique of vertical condensation of gutta-percha represents, in the correct indication, the optimal way of obturation of root canals. By following the manufacturer's recommendations and workflow the risks associated with this technique can be eliminated and a successful therapy can be reached.

Conflict of Interest: The authors deny any conflicts of interest related to this study.

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STRATEGIES FOR REDUCING RATIONED NURSING CARE: QUALITATIVE SECONDARY ANALYSIS

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Abstract

Introduction: Nursing students spend a meaningful part of their professional training in clinical practice. However, to a significant extent, they actively or passively contribute to the occurrence of rationed nursing care in clinical practice. Therefore, it is crucial that they actively participate in implementing targeted strategies to reduce rationed nursing care.

Aim: To explore nursing students´ experience with strategies focusing on the reduction of rationed nursing care.

Methods: We chose a qualitative secondary analysis to address unpublished data related to nursing students´ experience with strategies focusing on reducing rationed nursing care. The data included a set comprising of 148 pages with transcribed verbatim of 18 semi-structured interviews. The data were analyzed by a deductive content analysis.

Results: Based on the outcome of the secondary analysis, we identified two meaningful categories: Preventive strategies in clinical practice and Importance and meaning of preventive strategies. These two categories reflected nursing students´ experience with targeted strategies to reduce rationed nursing care in clinical practice.

Conclusion: Proposal and subsequent implementation of preventive strategies are essential for reducing rationed nursing care phenomenon from the clinical practice environment. The perspective of nursing students is vital due to their intensive perception of rationed nursing care in clinical practice. Students may identify areas that workplace staff may not explicitly focus on and consider important but jeopardize the quality of care or patient safety.

Keywords: nursing students, rationed care, strategies, secondary analysis

INTRODUCTION

The phenomenon of rationed nursing care has increased the concern of researchers in nursing worldwide. Rationed care is usually described as the withdrawal of necessary nursing care activities during the working shift of nurses (1). The occurrence of rationed nursing care relates primarily to the imbalance between nursing care needs and available resources, resulting in ethical problems violating nurses' professional and moral values (2). The phenomenon represents a global problem and is supported by many international studies showing that between 55 to 98 % of nurses do not provide at least one nursing care activity to the patients during their shifts (3). Approximately 87.6% of Slovak nurses rationed at least one nursing care activity (4). However, withholding any necessary activity significantly jeopardizes nursing care quality and patient safety (5). Moreover, the negative impact of the phenomenon was identified concerning nurses and healthcare organizations (4, 6). Therefore, a sys-

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tematic exploration of this phenomenon is necessary for various clinical settings. Up to date, many researchers have focused their studies on identifying types of care that are rationed, reasons for the occurrence of the phenomenon, and structural or organizational antecedents and consequences for nurses, patients, or organizations. Most of them have focused on investigating factors contributing to rationed nursing care with the aim to plan effective strategies focusing on its reduction or elimination from the clinical setting (1, 7). Nowadays, several strategies have been developed yet, such as adequacy of human resources, nurse-to-patient ratio, workload distribution, improvement of the working environment with increased teamwork and effective communication among all health professionals (8). Furthemore, Longhini et al. (9) identified eight strategies focusing on nursing care capacity, nurses´ performance, active engagement of nurses in rationed nursing care issues, nursing documentation, contrasting predictable issues, the system for detecting and managing risks, communication and collaboration, and the role of nurse leaders. Besides this, Cordeiro et al. (10) published recommendations for nurse managers to promote patient safety by minimizing rationed nursing care. However, most strategies have been designated only for nurse managers. Identifying and solving the individual preventive strategies directed to reducing rationed nursing care is not necessary only from their perspective. Meaningful perspectives should be provided by persons responsible for planning, delivering, and coordinating nursing care, including nursing students who are inseparable, albeit only a temporary part of the nursing team. Nursing students directly or indirectly contribute to the prevalence of rationed nursing care (11). However, nursing students´ experience with this phenomenon have been described only in three qualitative studies (12-14). These studies have not reported the nursing students´ perspectives on their experiences with preventive strategies and the importance of these strategies for clinical practice. Using nursing students´ experiences may provide us with a different perspective on preventative strategies and solutions of rationed nursing care.

METHODS

The method of a secondary analysis of the data (re-using existing datasets) with the aim to address new research questions represents the benefit that supports the advancement of nursing science. Supplementary secondary analysis might be used if the primary dataset has not been fully explored in the primary study (15). We conducted a secondary analysis based on the existing dataset obtained in 2019 (14). The primary analysis of the dataset was thematic, based on the interpretation and experience of nursing students with the concept of rationed nursing care in clinical practice. The current secondary analysis is supplementary to the published qualitative study. This study addresses meaningful data that have not been reported yet (16): experience with strategies focusing on reducing rationed nursing care and their importance for clinical practice from the nursing students´ perspective. The dataset comprised transcribed verbatim of eighteen semi-structured interviews conducted between February and October 2019. The primary research sample consisted of eighteen 3rd year nursing students from three universities in the Slovak Republic. The students were included in the sample based on the purposeful method. All of them were females aged between 21 and 33 (mean age 23.5). All of them were final year students of the bachelor study program. An interview guide was developed based on the literature review (12, 13). The interviews lasted between 18 to 26 minutes, were recorded using a voice recorder, and transcribed verbatim. The recordings were transcribed using Microsoft Word editor. The final dataset consisted of 148 pages of text. Prior to the data analysis, the assessment of the dataset re-usability was necessarily completed by determinants of accessibility, quality, and suitability (17). The assessment result indicated that the dataset was readily accessible, retained quality data, and was suitable for the planned analysis (Table 1). The data were analyzed by the method of a deductive content analysis (18).

Table 1 Determinants and assessment of the dataset re-usability (17)

Determinant	Assessment
Accessibility	• Original recordings and their transcripts were stored by one of the current study researchers, thus easily accessible. • The approval of the ethical committee was not required for the secondary analysis of the data previously approved by the ethical committee (EC no. 135/2018).
Quality	• One hundred forty-eight pages of transcribed verbatim recordings with eighteen nursing students from three universities represent a sufficient group size. • Transcribed verbatim recordings were adequate; in the context of the accuracy and credibility, several steps were followed, such as triangulation, peer debriefing, and member checking. • No data were missing (recordings, transcriptions). • The ability of the researcher to review and analyze the data was meaningful as the primary researcher was a co-author of the previously published paper.
Suitability	• Convergence between the aims of the previous and current study was declared: to better understand the nursing students´ experience with the concept of rationed nursing care. • The current study deepens the knowledge of the previously reported analysis and provides for the emergence of new knowledge.

RESULTS

Based on the secondary analysis results, we identified two categories: *Preventive strategies in clinical practice and Importance and meaning of preventive strategies.* The description of categories is supplemented with the participants´ statements.

Preventive strategies in clinical practice

Nursing students described their present experience with strategies to reduce or eliminate rationed nursing care from clinical practice. They stated that that they had not encountered these strategies in care units, as well as this phenomenon has not been given enough attention: *„How is it prevented? Come on...I do not think that anyone prevents this phenomenon in practice“* (S9). On the contrary, nursing students reflected on how they might support the more effective provision of nursing care. In addition, the students highlighted the need to increase the number of nurses and assistive personnel: *„...recruiting nursing aides or assistants could be the solution for this phenomenon“* (S7); or „they should try employing more personnel, especially nurses“ (S9). In case of increased numbers of personnel, nurses do not have to have overtime hours and there exists a possibility to call a nurse to the shift if the workload increases: *„there are wards with more staff; therefore, there is prevention that they (nurse managers) can call someone to the shift based on awareness of increased workload hence they will be pretty sure that situations at care units are manageable and nothing will be left neglected“* (S6). According to the students, another important factor is the organization of work at care units that mainly depends on the nurse manager who is responsible for assigning the tasks, effective delegating of tasks, or ensuring enough staff for providing nursing care: *„Probably it depends on assigning tasks or the whole management of the care unit. I think nurse manager is responsible for other´s knowing what to do“* (S10). With an effective task delega-

tion and its reliable implementation it is possible to reduce the prevalence of withdrawing necessary nursing care activities: *„For example, if one nurse will be assigned to particular patients, another nurse as well, it would be more effective...they (nurses) will have fewer patients hence there is the prevention of withdrawing nursing care activities"* (S4). The effective task delegation is also associated with an effective teamwork representing that each employee knows what to do: *„...by some reasonable delegation of tasks among colleagues because it is not entirely fair if one nurse is doing everything and the other one nothing...but also by talking with patients and physicians to ensure mutual communication in order to avoid situations when no one has seen a patient for the whole day because no one entered the room"* (S5). Based on the students´ statements, adequate communication and sufficient information about the patients often result in the provision of higher quality nursing care: *„if we sit in the morning and discuss about the adequate assignment of patients´ room and provide enough information about patients, then we basically avoid transferring responsibility for our work to others so we reduce rationed nursing care and no activity will be left missed"* S17). Nursing students commented that continuous education and workshops with the employees may have a positive impact on elimination of rationed nursing care: *„Maybe it is just education that keeps the brain tingling"* (S5), or *„...leading the workshops with employees, also about rationed care"* (S12). The students also gave several examples of how they could contribute to the decrease in prevalence of rationed care after graduation: *„I will try to do my best to help my patients. I will approach them equally, and definitely, I would like to improve their health status or conditions so they will feel quite good within the hospital setting"* (S10). The nurses´ attitudes to their profession seem to be the most effective preventative strategy: *„...by their attitudes and determination of priorities in care...just by keeping learning"* (S1). Self-management also plays a vital role: *„I would try to meet all patient needs to the extent that the patient needs...I would not miss any of those activities either in terms of biological needs, neither spiritual nor psychological"* (S9), as well as the time management of nurses: *„...to divide the interventions in time, to determine when to do something, not to postpone activities, such as to do documentation at first...to have any system and work according to it"* (S8). According to the students, the next step is to integrate novice nurses into the healthcare team effectively, to enhance their adaptation process, and focus on empowerment of the teamwork: *„The head nurse should educate nurses about the organization of work and motivate them. The critical aspect for novice nurses is to take a rest to not being emotionally exhausted from the beginning of their career..., so this is the role of the head nurse also"* (S6). The students also expressed the concerns that improvement suggestions might be implemented to the practice only if they are solved systematically: *„...this is essential to also talk about rationed nursing care among colleagues at wards but also among students...However, I think one person will not do anything about it"* (S13).

Importance and meaning of preventive strategies

Concerning the importance and meaning of strategies focusing on prevention of the rationed nursing care occurrence, nursing students in most cases concentrated on mutual satisfaction of both patients and nurses: *„...so that patients are satisfied with the care they received. And probably to prevent nurses from getting burned out...to make everyone satisfied"* (S8). The implementation of preventive strategies leads to the support of the effectiveness of the provision of nursing care, prevention of adverse event occurrence, patient outcome deterioration, and preterm mortality: *„...to avoid worsening of the patient's condition, prolongation of treatment, increase in costs and event death or irreversible damage of the patient"* (S12). By the provision of quality and safe care: *„...holistic patient care would be provided so that no nosocomial infections occur, to maintain the pressure ulcer prevention...so that necessary nutrition and hygiene care would be provided to our patients..."* (S7). The result of the described care is the satisfaction of the patient: *„...this is necessary for patients to provide them with all of their needs so that they are sa-*

tisfied with received care. We do not want them to express their concerns about incomplete care when leaving the hospital...it is all about patients and their satisfaction" (S9). The implementation of preventative strategies is also necessary for the prevention of burnout syndrome. The students believe that if there is an effective organization at wards, nurses are more motivated; thus, the risk for burnout syndrome is lower: *„...if there is adequate planning of the work and no one is forced to provide the routine care for patients...and the work is constantly changing, and no one is missing something...so that the work is dynamic. These are strategies for eliminating burnout syndrome"* (S4). Furthermore, the students realize that if they use the up-to-date knowledge in clinical practice, they might be role models for other novice nurses, thereby improving nursing care and preventing it from withholding: *„...students entering clinical practice should be role models for further generations. They should follow the standard procedures and utilize the up-to-date knowledge in their practice"* (S3). The positive aspect of the implementation of preventive strategies is the increase in the welfare of the organization, production of satisfactory outcomes, and the provision of higher quality healthcare: *„...also the image of the particular wards might be impaired due to poor patient outcomes such as unexpected death or deteriorations in patient´s condition...primarily, the wards should have good organization of work and produce good results. If not, or no one knows own competencies...then it is not such a proper procedure"* (S6). Moreover, the students perceived particular gaps within the provision of nursing care, while the statement: *„...to carry out all of the nursing care activities...that the patient care is accurate, not only recorded on the paper"* (S11) supports the importance of nursing care activities being genuinely implemented and the nursing documentation being recorded truthfully and that the patient has all of his/her needs saturated pleasingly, because: *„We never know when we will be lying on that bed"* (S10).

DISCUSSION

The secondary analysis of the qualitative data aimed to explore nursing students´ experience with strategies focusing on reducing rationed nursing care. The study revealed some important information about the awareness, importance, and meaning of preventing strategies to reduce rationed nursing care.

In general, rationed nursing care and contributory factors are frequently assessed by various instruments, as they may also reveal significant predictors that need to be addressed in the context of applying the preventive strategies, especially those related to the organizational aspects and the work environment of nurses, staffing and material resources of the workplace, communication and relationships, and management and support (3, 19). Several studies have shown that by identifying factors and predictors of the rationed nursing care phenomenon, hospital management may develop and subsequently implement targeted strategies to eliminate this phenomenon from the clinical practice environment (1, 20). However, the mentioned studies focused on delineating factors and predictors of this phenomenon from the perspective of nurses working mainly in standard care units. According to Farzi et al. (21), nursing students have the potential to propose and subsequently implement effective strategies aimed at improving the clinical environment, which we have confirmed in our study. The view of nursing students can help clarify problematic areas in clinical practice. The nursing students´ experience with rationed nursing care during their clinical practice was further specified in another study (14). We confirmed that the view of nursing students brings completely new dimensions to this issue. In our research, the students stated that they did not encounter implemented prevention strategies during their clinical teaching, but they understand their significance and importance. Concerning the workplace where they practiced, they proposed implementing several strategies, while among the most important they included an increase in the number of

staff. However, according to national and international studies, the inadequate staffing of the workplace is a global problem (19, 22). In the Slovak Republic, staffing is exacerbated mainly by insufficient determination of staff competencies, inadequate nurse-patient ratio, and inefficient delegation of tasks (22). The students stated that increasing the number of staff would reduce the number of overtime hours for the nurses and provide space for regeneration. The number of overtime hours is also one factor that negatively affects the incidence of rationed nursing care (23). From the perspective of effective management, they proposed a fair redistribution of work in the workplace by the head nurse and the provision of a sufficient number of qualified staff based on competencies. Effective redistribution of tasks is also closely related to the effective delegation of independent nursing activities to lower medical staff. However, a precise determination of the competencies of healthcare professionals is essential for this step. In the Slovak Republic in 2018, there was a change in educational content and the competencies of healthcare assistants who were renamed to practical nurses. This change deepened the unclear determination of staff competencies (24). In the beginning of 2021, the Slovak nursing practice registered another significant change, namely the renaming of practical nurses to nursing assistants, but without a difference in the existing regulation on the scope of training provided by healthcare assistants. This fact will again bring problems with the determination of competencies. Other preventive strategies proposed by the students included continuous education, self-management, time management, and effective prioritization of provided care. However, the implementation of these strategies is related to the nurses' inner values and beliefs and, according to the students, the nurses must initiate a change (25). The students consider implementing scientific seminars, integrating novice nurses into the healthcare team, and improving teamwork within the strategies. This teamwork mainly informs the healthcare team about the patient and treatment procedures (12). According to them, the implementation of these strategies could lead to the provision of safe and high-quality nursing care with an emphasis placed on the prevention of adverse events, increased health protection, prevention of deterioration of patients and premature mortality, as well as support for burnout syndrome prevention and support for future generations of nurses. According to Bagnasco et al. (11) a higher quality of nursing care might be achieved by supporting nursing students by raising awareness of dissonance, critical reflection, and developing their critical thinking, strengthening nursing values in practice and close cooperation.

CONCLUSION

The proposal and subsequent implementation of preventive strategies are necessary to reduce or eliminate the phenomenon of rationed nursing care from the clinical practice environment. The perspective of nursing students is essential, given their intense perception of the rationed nursing care in clinical practice. The students can also identify areas that workplace staff do not perceive as threatening patient quality and safety. In our research the students declared that they did not encounter preventive strategies that impede head nurses or hospital management for their targeted implementation. Although nursing students are a temporary part of the nursing team, they might become permanent members over time. The management of hospitals, thus, offers space for their motivation to enter the workplace and introduce specific prevention strategies and, thus, improve patient care.

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IMPACT OF COVID-19 ON LIFESTYLE RELATED BEHAVIORS OF NIGERIANS

A CROSS SECTIONAL SURVEY

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Abstract

Introduction: A great threat of a novel virus – coronavirus otherwise known as COVID-19 pandemic rocked the entire world in the wake of the year 2020. The threat is so strenuous that the entire world was placed on lockdown in the matter of social restriction such as on international and national transport links, market or business transactions, school and organizational activities, and all related social and religious gatherings. This restriction might change people's lifestyle. This study was aimed at assessing the lifestyle changes caused by the pandemic among Nigerians.

Methodology: A web based cross sectional survey was conducted using an e-questionnaire. A paired t-test, independent t-test were used to test hypothesis while mean, frequency, and percentage were used to summarize the data.

Results: Majority of the participants were male (72.1%), single (83.2%), and middle class (79.5%) of social status. There was a decrease in the habit of consuming meals routinely at regular intervals during COVID-19 (19.4% vs 25.7%). There were significant differences in eating patterns before and during COVID-19 ($P<0.05$). Likewise, significant differences in physical activity before and during COVID-19 were observed.

Conclusion: Some of the protocol put in place in curtailing the virus has been proven to have a positive impact on the lifestyle of Nigerians Such health benefits include but not limited to an increase in moderate exercise, increase in the consumption of healthy and reduction in the consumption of unhealthy food.

Keywords: COVID-19, sleep pattern, unhealthy eating behaviors, sedentary life, alcohol

INTRODUCTION

A great threat of a novel virus – coronavirus otherwise known as COVID-19 pandemic rocked the entire world in the wake of the year 2020. COVID-19 which was first reported in December 2019 in Wuhan China, declared as Public Health Emergency of International Concern in January 2020 and later a pandemic in March 2020 [1]. Nigeria recorded its first case of COVID-19 on the 27th February, 2020. This index case was an imported case by an Italian on a business trip to Ogun state, Nigeria [2]. The threat is so strenuous that the entire world was placed on lockdown in the matter of social restriction such as international and national transport links, market or business transactions, school and organizational activities, and all related social and religious gatherings. This restriction might change people's lifestyle [3]. Being a novel disease that is highly contagious, spreading fast across the world, and the fact that there is yet to be an established cure for it, the COVID-19 pandemic has created a lot of panic in every part of the world [4].

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COVID-19 is a global burden which continues to redefine daily lifestyle-related habits in a significant manner as the pandemic progresses through its different phases. Public health recommendations and government measures taken to abate infection have indirectly impacted food availability, dietary quality, normal daily activities, access to recreational public settings, social activities, work and financial security [5]. These compound over time to radically change lifestyle-related behaviors, especially daily eating, activity and sleep behaviors that are known to be independent risk factors for metabolic complications such as obesity, diabetes, and cardiovascular disorders [6-7]. Though the finding of Chopra et al. [8] revealed that people improve slightly in terms of consuming meals at regular intervals routinely basis during COVID-19. Regular pattern as a construct is often described as an individual eating pattern at the level of meal such as a main meal (example breakfast, lunch, snack) or a smaller-sized meal (example super or snack) [9]. Certain experts believe that a proportion of individuals may have marginally improved metabolism and other health outcomes during the COVID-19 pandemic by adhering to the following dietary behaviors: (i) reducing meal frequency, (ii) consuming regular (i.e., breakfast (about 40% of daily total energy)), lunch (30% of daily total energy), and dinner (30% of daily total energy) and having good quality meals (e.g., more fresh vegetables, good quality protein source, avoiding refined and high glycemic foods) [10]. A reduction in engagement in a physical activity at all levels coupled with increase in daily sitting and screen time due to confinement was prominently found across all the literature [11].

Few studies from the West have highlighted a negative impact on various lifestyles related behaviors as a potential implications of COVID-19. However, the interplay of the severity of COVID-19 infection with different social, economic, and cultural constructs in determining the extent of changes in lifestyles related behaviors might vary from country to country. Thought there's previous study on psychological distress experiences of Nigerians during COVID-19 pandemic. In Nigeria there is no empirical finding (to the best knowledge of the investigators) establishing the impact of COVID-19 pandemic on lifestyle related behaviors of the general population. Hence we focused to find the impact of COVID-19 on lifestyle related behaviors of Nigerians.

METHODS

Research Design and Population of the Study.

The population of this study were Nigerians on social media and the study was a cross-sectional e- survey.

Sample Size Calculation

The required sample size for this cross-sectional study was estimated using the formula below $n = Z^2 P (1 - P)/e^2$ [12].

Where Z = 1.96; P = 90% (0.9) as the response rate of the online survey [13], and e = 5%. Therefore, the minimum number of participants required for this study was 139.

Inclusion and Exclusion criteria

Any Nigerian with an access to the Internet was eligible to participate. However, individuals below the age of 18 were excluded.

Sampling Technique

A purposive sampling technique was used to recruit the participants for this study.

Data Collection Instrument

The instrument used was adopted from Chopra et al [8]. This questionnaire contains two sections A and B; section A obtains information on socio-demographic characteristics of the participants such as gender, age, ethnicity, marital status, occupation. Section B assess changes in different lifestyle-related behaviors such as eating habits, physical activity, sleep, and other health related behaviors during the COVID-19 outbreak. Part A (A1 to A24) of section B evaluates the lifestyle related behaviors before COVID-19 and Part B (B1 to B24) asses-

ses changes in the lifestyle related behaviors during COVID-19. The questionnaire was scored using a five point Likert responses, namely 'not routinely', 'one to two times a week', 'three to four times a week', 'five to six times a week', and 'almost daily'. The magnitude of the responses ranges from 5 (most acceptable behavior) to 1 (least acceptable behavior). The questionnaire is an extension of already developed questionnaire with chronbachs alpha of 0.72 [14].

Ethical Consideration

Ethical clearance was granted by the research ethics committee of the Kano State Ministry of Health with a reference number MOH/Off/797/T.I/2106 before the commencement of the study.

Method of Data Collection

The purpose of the study, informed consent form along with the questionnaire were sent to the participants using Google form. The participants were asked to share the link to others and paste it on their social media pages.

Data Analysis Procedure

SPSS version 20 was used to analyse the data at an alpha level of 0.05. Frequency, percentage, mean, and standard deviation were used to summarize the data. Paired t-test was used to assess the differences in lifestyle behaviour before and during COVID-19 lockdown while ANOVA and independent t-test were used as appropriate to check the differences in lifestyle behaviours during COVID-19 and socio-demographic variables of the respondents.

RESULTS

Sample Description

The demographic details of the included participants (n= 190) is shown in **Table 1.** The sample has a higher male participation (72.1%) with the mean age of 26.89±5.95 (ranges, 17–58) years. There were more single participants (83.2%), Hausa (56.8%) by tribe, with tertiary education (93.7%) and middle class (79.5%) of social status.

Table 1 Characteristics of the participants

Variables	Frequency	Percentage
Age	26.89±5.95	(17-58)
Gender		
Male	137	72.1
Female	53	27.9
Marital status		
Single	158	83.2
Married	32	16.8
Tribe		
Hausa	108	56.8
Igbo	12	6.3
Yoruba	49	25.8
Other	21	11.1
Level of education		
Non-formal	2	1.1
Secondary	10	5.3
Tertiary	178	93.7
Socio-economic status		
Low	28	14.7
Middle	151	79.5
High	11	5.8

Responses from the Survey

The responses for differential items assessing the changes in lifestyle-related practice before and during COVID-19 are given in **Table 2.** There was a decrease in the habit of consuming meals routinely at regular intervals during COVID-19 19.4% vs 25.7%). There was a decrease in unhealthy eating behaviors such as consumption of fried food (5.3% vs 4.6%), junk food (4.5% vs 4%), consumption of foods with high sugar (9.3% vs 46.7%), and emotional eating (4% vs 37.4%). However, an improvement was seen in the frequency of consumption of pulses, meats, and eggs (6.7% vs 7.4%) during COVID-19 but a decrease in fruits and vegetables (9.7% vs 5.9%) intake.

In the physical activity domain, an increase in participants exercising for 30 min was observed (4.3 vs 24.5%). An increase in participation in household chores was seen (15.1% vs 32.4%), participation in leisure related activities (9,2% vs 24,7%). However, daily screen time of has reduced during COVID-19. Participants reporting more than 8 hours of sleep increased (15.8% vs 18.9%) but the overall quality of sleep marginally declined (16.8% vs 15.8%) and overall stress amongst the participants slightly increased (2.1% vs 2.6%). There was a decrease in the rate of smoking (3.7% vs 1.1%), alcohol consumption (1.1% vs 0), and social support (9.5% vs 4.7%).

Table 2 Frequency of the participant's responses

Variables	Before COVID-19	During COVID-19
EATING BEHAVIOR		
1. **Consumption of regular meal pattern**		
Not routinely	38 (20.8)	37 (25.7)
One to two times a week	54 (29.5)	40 (27.8)
Three to four times a week	19 (10.5)	20 (13.9)
Five to six times a week	25 (13.7)	19 (13.2)
Almost Daily	47 (25.7)	28 (19.4)
2. Consumption of fast food		
Not routinely	71 (40.8)	55 (41.0)
One to two times a week	64 (36.8)	51 (38.1)
Three to four times a week	28 (16.1)	17 (12.7)
Five to six times a week	7 (4.0)	7 (4.0)
Almost Daily	4 (2.3)	4 (2.3)
3. Consumption of fried food		
Not routinely	42 (24.6)	39(30.0)
One to two times a week	78 (45.6)	56 (43.1)
Three to four times a week	26 (15.2)	18 (13.8)
Five to six times a week	16 (9.4)	11 (8.5)
Almost Daily	9 (5.3)	6 (4.6)
4. Consumption of junk foods as snacks		
Not routinely	74 (42.3)	51 (38.6)
One to two times a week	63 (36.0)	51 (38.6)
Three to four times a week	16 (9.1)	51 (38.6)
Five to six times a week	15 (8.6)	8 (6.1)
Almost Daily	7 (4.5)	6 (4.0)
5 Frequency of your fruits and vegetables intake		
Not routinely	42 (23.9)	32 (23.7)
One to two times a week	68 (38.6)	53 (38.5)
Three to four times a week	30 (17.0)	23 (17.0)
Five to six times a week	19 (10.8)	20 (14.8)
Almost Daily	17 (9.7)	8 (5.9)

Continuation of table table 2 Frequency of the participant's responses

Variables	Before COVID-19	During COVID-19
6. Consumption of balanced diet including healthy ingredients (whole wheat, pulses, legumes, eggs, nuts, fruits and vegetables)		
Not routinely	42 (23.5)	32 (23.5)
One to two times a week	60 (33.5)	51 (37.5)
Three to four times a week	34 (19.0)	15 (11.0)
Five to six times a week	27 (15.1)	27 (19.9)
Almost Daily	16 (8.9)	11 (8.1)
7. Consumption of milk or its products (curd, chhachh, lassi, cheese, paneer, etc.)		
Not routinely	53 (29.4)	38 (28.6)
One to two times a week	54 (30.0)	48 (36.1)
Three to four times a week	36 (20.0)	25 (18.8)
Five to six times a week	27 (15.0)	12 (9.0)
Almost Daily	10 (5.6)	10 (7.5)
8. Consumption of one or more servings of pulses, eggs, or meat in a day		
Not routinely	46 (25.8)	34 (25.0)
One to two times a week	58 (32.6)	56 (41.2)
Three to four times a week	37 (20.8)	22 (16.2)
Five to six times a week	25 (14.0)	14 (10.3)
Almost Daily	12 (6.7)	10 (7.4)
9. Daily consumption of sugar/honey/jaggery		
Zero teaspoons per day, I don't add sugar in my meals/beverages	144 (14.5)	49 (36.0)
One to two teaspoons per day	56 (32.0)	46 (33.8)
Three to four teaspoons per day	22 (12.6)	19 (14.0)
Five to six times teaspoons per day	16 (9.1)	12 (8.8)
More than 6 teaspoons per day	20 (11.4)	10 (7.4)
10. Consumption of sugar sweetened beverages		
Not routinely	56 (31.6)	43 (31.9)
One to two times a week	51(28.8)	56 (41.1)
Three to four times a week	36(20.3)	14 (10.4)
Five to six times a week	20 (11.3)	8 (5.9)
Almost Daily	14 (7.9)	53 (40.2)
11 Consumption of foods with high sugar		
Not routinely	65 (37.8)	39 (29.5)
One to two times a week	53 (30.8)	17 (12.9)
Three to four times a week	26 (15.1)	12 (9.1)
Five to six times a week	12 (7.0)	11 (8.3)
Almost Daily	16 (9.3)	63 (46.7)
12. Emotional eating (boredom/distress/disappointment)		
Not routinely	88 (50.6)	45 (33.3)
One to two times a week	47(27.0)	13 (9.6)
Three to four times a week	23(13.2)	10 (7.4)
Five to six times a week	9 (5.2)	4 (3.0)
Almost Daily	7 (4.0)	52 (37.4)

Continuation of table table 2 Frequency of the participant's responses

Variables	Before COVID-19	During COVID-19
Physical activity		
13 Participation in 30 min of moderate intensity aerobic exercises/sports		
Not routinely	69 (37.3)	47 (33.8)
One to two times a week	62(33.5)	26 (18.7)
Three to four times a week	31(16.8)	6 (4.3)
Five to six times a week	15 (8.1)	8 (5.8)
Almost Daily	8 (4.3)	34 (24.5)
14 Participation in household chores (cooking, laundry, cleaning)		
Not routinely	42 (22.6)	42 (30.2)
One to two times a week	53(28.5)	25 (18.0)
Three to four times a week	41(22.0)	15 (10.8)
Five to six times a week	22 (11.8)	23 (16.5)
Almost Daily	28 (15.1)	46 (32.4)
15 Participation in leisure related activities (grocery shopping, walking in park, gardening)		
Not routinely	44 (23.9)	42 (29.6)
One to two times a week	47(25.5)	27 (19.0)
Three to four times a week	52(28.3)	18 (12.7)
Five to six times a week	24 (13.0)	9 (24.7)
Almost Daily	17 (9.2)	47 (24.7)
16 Daily sitting time at work		
Less than 2 h	28 (14.7)	23 (12.1)
2-4 h	34(17.9)	38 (20.0)
4-6 h	64 (33.7)	39 (20.5)
6-8 h	34(17.9)	30 (15.8)
More than 8 h	20(10.5)	13 (6.8)
17 Breaks from sitting (such as standing up, stretching, or taking a short walk)		
0 breaks	9 (4.7)	11 (5.8)
1-2 breaks	97 (51.1)	74 (38.9)
3-4 breaks	63 (33.2)	35 (18.4)
5-6 breaks	23 (12.1)	9 (4.7)
More than 6 breaks	11 (5.8)	12 (6.3)
18 Daily screen time		
0-1 h	18 (9.5)	16 (8.4)
1-2 h	56 (29.5)	37 (19.5)
3-4 h	54(28.4)	35 (18.4)
4-5 h	23 (12.1)	23 (12.1)
>5 h	33(17.4) 28 (14.7)	
Sleep pattern		
19 Daily hours of sleep		
<6 h	52 (27.4)	37 (19.5)
6-8 h	107 (56.3)	69 (36.3)
>8 h	30 (15.8)	36 (18.9)

Continuation of table table 2 Frequency of the participant's responses

Variables	Before COVID-19	During COVID-19
20 Quality of sleep		
Excellent	32 (16.8)	30 (15.8)
Very good	75 (39.5)	52 (27.4)
Good	74 (38.9)	52 (27.4)
Bad	6 (3.2)	9 (4.7)
Very bad	1 (0.5)	0
21 Level of stress or anxiety		
Not at all	22 (11.6)	16 (8.4)
A little	111 (58.4)	82 (42.3)
Much	39 (20.5)	28 (14.7)
Very much	13 (6.8)	11 (5.8)
Extremely	4 (2.1)	5 (2.6)
Other behaviors		
22 Smoking		
No	170 (89.5)	130 (68.4)
Yes, 1-3 cigarettes per day	10 (5.3)	9 (4.7)
Yes, 4-6 cigarettes per day	7 (3.7)	2 (1.1)
23 Alcohol consumption		
No	161 (84.7)	119 (62.6)
Yes, on special occasions	24 (12.6)	21 (11.1)
Yes, on weekends	1 (0.5)	1 (0.5)
Yes, almost daily	2 (1.1)	0 (0)
24 Social support		
Always (more than 90% times)	44 (23.2)	33 (17.4)
Most of the times (approx. 75% times)	41(21.6)	39 (20.5)
Sometimes (approx. 50% times)	71 (37.4)	46 (24.2)
Occasionally (approx. 25% times)	13 (6.8)	12 (6.3)
Rarely (approx. 10% times)	18 (9.5)	9 (4.7)

Impact of COVID-19 on Lifestyle-related behavior: Before and during COVID-19 Comparison

The comparison of mean scores of lifestyle related behaviors before and during COVID-19 is shown in **Table 3**. There were significant differences in eating patterns before and during COVID-19 which were observed in regular meal patterns, consumption of fried foods and sugar sweetened beverages (P<0.05).

There were significant differences in physical activity before and during COVID-19 which were observed in leisure related activities and daily sitting time (P<0.05). There were no significant differences in sleeping pattern, smoking and alcohol consumption before and during COVID-19 (P>0.05) however, a difference was seen in daily hours of sleeping (P<0.05).

Table 3 Comparison of mean scores of lifestyle related behavior before and during COVID-19

Variables	Before COVID-19	During COVID-19	p-value
EATING BEHAVIOR	**29.34**	**28.74**	**0.00***
Consumption of:			
1 Regular meal pattern	2.94	2.75	0.04*
2. Fast food	1.90	1.91	0.87
3. Fried food	2.29	2.12	0.05*
4. Junk foods as snacks	1.98	2.02	0.73
5 Frequency of fruits and vegetables intake	2.48	2.41	0.50
6. Balanced diet including healthy ingredients	2.47	2.50	0.67
7. Milk or its products	2.38	2.33	0.53
8. One/more servings of pulses, eggs/meat in a day	2.50	2.36	0.15
9. Daily consumption of sugar/honey/jiggery	2.27	2.19	0.36
10. Consumption of sugar sweetened beverages	2.39	2.19	0.02*
11 Consumption of foods with high sugar	2.16	2.16	0.93
12. Emotional eating	1.81	1.87	0.59
Physical activity	**7.47**	**7.12**	**0.02***
13 30 min of moderate intensity aerobic exercises	2.13	2.09	0.68
14 Household chores (cooking, laundry, cleaning)	2.64	2.64	1.00
15 Leisure related activities (grocery, shopping)	2.63	2.33	0.03*
16 Daily sitting time at work	2.79	2.50	0.04*
17 Breaks from sitting (such as standing up)	2.99	3.09	0.20
18 Daily screen time	2.59	2.44	0.04*
Sleep pattern	**9.39**	**9.51**	**0.20**
19 Daily hours of sleep	1.84	1.99	0.00*
20 Quality of sleep	3.74	3.71	0.60
21 Level of stress or anxiety	3.74	3.75	0.89
Other behaviors			
22 Smoking	2.86	2.91	0.13
23 Alcohol consumption	4.85	4.85	1.00
24 Social support	3.54	3.53	0.93

Association of Lifestyle-related behavior with demographics

There were significant differences between gender and level of physical activity during COVID-19. Likewise, a significant differences were seen between social classes and sleep pattern (P<0.05).

Table 4 Association of demographic variables with mean difference of During COVID-19 Lifestyle-related scores

Variables	Eating behaviors	PA	Sleep pattern	Test
Gender	0.38	0.03*	0.14	t-test
Marital status	0.27	0.40	0.25	t-test
Residence area	0.07	0.11	0.70	t-test
Level of education	0.09	0.29	0.08	ANOVA
Social class	0.17	0.51	0.01*	ANOVA

PA= Physical activity

DISCUSSION

The outcome of this study revealed that there was a decrease in the daily consumption of regular meal pattern during COVID-19 as compared to before COVID-19. This might be due to a high impact of the COVID pandemic on the country's economy or the effect of the lockdown measures on their sources of income. Also, we found a significant decrease in the consumption of unhealthy foods such as fried foods and junk foods before and during COVID-19. This might be due to lack of access to restaurants or other recreational places where these unhealthy foods are being sold due to the impact of the lockdown imposed by the government. However, there was a significant increase in the consumption of healthy foods such as one or more servings of pulses, eggs, or meat in a day, and consumption of milk or its products during COVID-19 as compared to before COVID-19. This result could be a reflection of the awareness provided by the professional health bodies through mass and social media about healthy eating in order to boost immunity. Notable is that the level of emotional eating increased significantly during COVID-19 as compared to before COVID-19 which was hypothesized to be due to the fact that people were bored and had restricted physical participation in social activities.

On the impact of COVID-19 on physical activity level, the outcome of this study revealed that majority of the participants had increased participation level by 30 minutes of moderate intensity aerobic exercises during COVID-19 as compared to before COVID-19 which was associated with the health awareness and sensitization about the benefits of exercise and physical activities on mass media during the COVID-19 lockdown. Concurrently with moderate exercise, the level of participation in household chores such as cooking, laundry, cleaning, and leisure related activities such as grocery shopping, walking in park, gardening was also found to have increased significantly during the COVID-19 as compared to before the COVID-19 outbreak. However, the result of this study was contrary to the findings of Stephanie et al [15], which revealed a decrease in the level of physical activities during COVID-19 compared to before COVID-19.

Majority of the participants in this study had increased the level of daily hours of sleep during COVID-19 as compared to before COVID-19. This could be because people had to stay indoors, had lesser outdoors activities to participate in, and had lesser tasks to perform. However, the result of this study revealed no significant differences in the quality of sleep during COVID-19 compared to before COVID-19 outbreak. This is contrary to the result of a

study carried out by Martínez-de-Quel et al [16], which reported a significant decline in the quality of sleep during the COVID-19 lockdown among a Spanish sample.

Majority of the participants had reduced stress level during the COVID-19 outbreak as compared to the level of stress before COVID-19 due to the fact that people had more time to rest at home or had to work from home as it may be. There was no significant difference in the rate of smoking and alcohol intake during COVID-19 outbreak as compared to before COVID-19 outbreak. This is consistent with the earlier findings by Guignard et al. [17] who reported no significant difference in the level of smoking and alcohol intake during the COVID-19 outbreak as compared to before the COVID-19 outbreak in France.

The existing study shows that there were significant differences between gender and physical activity, there was a significant decline in physical activity level among the studied population which was seen to be higher in men, this was concurrently similar in another study which showed that physical inactivity was higher in men and reduction in moderate intensity aerobic exercises as well as leisure related activities coupled with an increase in daily screen and sitting time due to confinement [8].

It was evident in this study that there was a significant difference between social class and sleep pattern among the participants, the time spent daily on screen time increased in which the sleeping quality of most of the participants belonging to upper socio-economic groups declined, this was equally shown in a study by Chopra et al. [8] that their studied participants reported more than 8 hours of sleeping but the overall quality of sleep marginally declined in which most of the participants belonging to upper socio-economic groups.

CONCLUSION

Even though, COVID-19 is a dreadful virus which has caused a lot of setback in both national and international economies as well as reduction in people's standard of living, some of the protocol put in place in curtailing the virus has been proven to have positive impact on the lifestyle of Nigerians. Such health benefits include but not limited to an increase in moderate exercise, increase in the consumption of healthy and reduction the consumption of unhealthy food. These above mentioned good health practice will go a long way preventing individuals from being overweight or obese which is a very important risk factor for many diseases.

Limitation

The study does not involve larger numbers of Nigerians to ascertain the generalizability of the current findings. It is also possible that the outcomes would vary if measured over a thousand or more participants. Also, the issue of response bias, which is prevalent in self-report surveys, could have influenced the results and considered a limitation to this study.

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