

Role of Sleep Inadequacy and Altered Food Patterns Leading to Loss of Glycaemic Control.

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Abstract

Diabetes mellitus is a major growing health problem affecting more than 180 million people worldwide. HbA1c or glycated haemoglobins are biosynthesised by means of glycosylation of haemoglobins. Earlier, several studies proven that insulin resistance among the obese patients and those with relatively sedentary lifestyle can develop which could result in the elevated levels of HbA1c. The current review shed light on the role of sleep inadequacy and altered food patterns leading to loss of glycaemic control.

Key words: Diabetes mellitus, glycated haemoglobins, insulin resistance, sleep inadequacy

INTRODUCTION

Diabetes mellitus is a major growing health problem affecting more than 180 million people worldwide. As a growing challenge in India has an estimated 8.7% diabetic population in the age group of 20 and 70 years as per WHO(1). It is hypothesised that the diabetic population in India might rise to nearly 79.4 million. According to the estimates the number is expected to double by 2030(2). Co-morbid conditions like hypertension, dyslipidemia, neuropathy, coronary vascular diseases and nephropathy associated with Diabetes mellitus present a major public health concern globally (3). The management of type 2 diabetes mellitus is progressively becoming complexed and somewhat disputable as there are a wide range of therapeutic agents available to serve the purpose. Due to this reason it is building concerns about their probable adverse effects and new hypotheses that might be uncertain regarding the benefits of glucose level control on macrovascular complications (4). Type 2 diabetes mellitus is categorised as a lifestyle disease and diet related chronic disease which has some aetiological relationship between alterations in food patterns and less physical activities. Diabetes is proving to be major threat to individual and national progress. Socially and economically diabetes mellitus is posing its complications which impacts negatively the developed and developing world economic regions (5). In the previously established literatures are concerned, there has been studies that reflect how dramatically the insulin resistance among the obese patients and those with relatively sedentary lifestyle can develop which could result in the elevated levels of HbA1c. In a crosssectional study carried out by, established that hyperglycaemic patients can optimize their lifestyle towards health once they gain the knowledge of managing the complication effectively. The form of lifestyle which could prove to be one of the contributing factors to uncontrolled HbA1c levels in an individual (6). Another study conducted by Inoue *et al*, established that other than the known risk factors such as age, gender, BMI, triglycerides, serum Alanine aminotransferase and white blood cell count, there certain risk factor which are yet to be addressed. However, the combined presence of IFG and elevated HbA1c, are the best predictive markers

of diabetes that might prove essential for the preventive measures to be taken by the individuals (7). The current review shed light on the role of sleep inadequacy and altered food patterns leading to loss of glycaemic control.

Factors contributing to altered glycaemic control

Obesity: Previously Obesity and Type 2 diabetes mellitus were considered to be an age oriented disease. However, there has been an increase in the number of weight gain and newly diagnosed T2DM cases among children and adolescents. Obesity is considered as one of the most critical health problem across the globe. Type two diabetes mellitus currently affect every 1 in 10 individuals in the United States alone.

Sleep: A study conducted by Daniel J Gottlieb *et al*, they established a positive prevalence relationship between Diabetes mellitus and Impaired glucose tolerance and a sleep, whose duration is less than 9 hours. They further established that voluntary sleep obstruction can be a major factor for uncontrolled glycaemic levels (8). However, only experimental studies have suggested that there is a positive relationship between deprived sleeping habits and the onset of type diabetes mellitus (9). Some studies have suggested that an increased capability of diet have a relationship with a reduced risk of type 2 diabetes mellitus especially in women (10).

Food: In a recent clinical study, it was demonstrated that a deviation or change in the lifestyle which includes a reduced ingestion of calories and inclusion of a physically active lifestyle prevents the onset of cardiovascular diseases in patients previously diagnosed with type 2 diabetes mellitus (11). Apart from intake of high calorie diet, the lack of minimum availability of the required nutrition and food, which is also termed as Food insecurity, has also been found as one of the most prevalent concerns that lead to Type 2 diabetes mellitus (12). In some parts of the world namely in Asia, The Economic Research Survey, it has been reported that 20% of the population suffered from hunger due to food scarcity (13). Followed by Food insecurity, psychological dysregulations such as depression also occurs which results in obesity, which are again an imperative conjurers for type 2 diabetes mellitus (14). Intake of fast food which

is a type of pro-inflammatory diet, they enhance the impact of obesity, and that leads to the development of type 2 diabetes mellitus (15).

Other factors: Smokers with diagnosed type 2 diabetes mellitus were found to have 50% more chances of mortality with other cardiovascular complications as compared to non-smokers (16). The asymmetric smoking, and its abrupt withdrawal and mortality indicates presence of additional risk factors that possess a higher cardiovascular risk in abrupt withdrawers of cigarette and is irreversible by short term avoidance from smoking (17). Alcohol intake by individuals with a diagnosis of type 2 diabetes mellitus express increased prevalence of diabetes mellitus(18) by increasing the adiposity

Association between sleep inadequacy, altered food patterns and the loss of glycaemic control.

Sleep Deprivation, Obstructive sleep apnoea and insulin resistance

A study led by J.M.M Evans *et al*, illustrated a strong association between deprivation of the essential necessities and obesity within their study population, which is a very prevalent factor for the presence of type 2 diabetes mellitus (19). From the studies and surveys performed in the American population it has been illustrated that the majority of the population that are deprived of sleep are belonging to 40-59 years (middle aged) irrespective of their type of exposure to the respective social environments. Table 1 shows the distribution of the different age groups facing sleep deprivation and the percentage of those suffering from the type 2 diabetes mellitus. Decisively it was also found that the age group majorly sleep deprived have higher prevalence rates of developing type 2 diabetes mellitus as compared to the other aged groups. From a study conducted by the Sleep Heart Health Study, it was established that smaller duration of sleep or insufficient sleep by means of voluntary bed-time abstinence are having absolute chances for the individuals to develop diabetes mellitus(20).

Food Patterns affecting Glycaemic control

Food, eating patterns and nutrition has got a primitive role to play in the development of diabetes and also loss of glycaemic control over the patients already suffering from type 2 diabetes mellitus. The concept of medical nutrition therapy have been proved to exhibit improvement in glycaemic control in individuals suffering from diabetes (21), studies regarding which have shown 0.5% to 2% reduction in HbA1c levels in type 2 diabetes mellitus patients (22, 23). Maintaining a lower level of HbA1c has been proved reduce the vulnerability of renal damage, retinopathy, neuropathy and cardiovascular problems (24).

Increased Substance Abuse and Diabetes

Substance use for example, the use of tobacco, alcohol, abuse of prescribed drugs are very prevalent among the patients with type 2 diabetes mellitus in the United States and the prevalence has been illustrated in table 3. Patients with diabetes practising substance abuse and have the associated comorbidities are at higher risk for worsening of the existing medical complications and might result in hospitalization Substance abuse are reported to cause most

of the vital organ damage namely heart and kidneys (25, 26). Binge alcohol consumption has been found to increase diabetic keto-acidosis, peripheral neuropathy and retinopathy.

Alcohol Abuse and Diabetes Prevalence

The dual existence of diabetes and alcohol addiction increases the effects of the co-morbidities that are associated with type 2 diabetes mellitus (27). Alcohol has also been proved to reverse the medication adherence and self-care (28). The inclusion of alcohol and other medications use disorders result were found to be in positively proportionate with having reduced odds of adherence with the magnitudes of quality of the services for type 2 diabetes mellitus as compared to those without substance abuse issues (26).

Cigarette smoking and Diabetes

Several studies have established the relationship between smoking cigarettes and induction of type 2 diabetes mellitus, hyperinsulinemia, hypertension and endothelial dysfunction. Cigarette smoking progresses the vulnerability of the risk for development of undesirable noxious effects namely cardiovascular diseases, neuropathy and renal dysfunction also (29). The healthcare professionals thereby are required to address the smoking abuse situation in order to synergise the treatment and adherence to the treatment of patients with type 2 diabetes mellitus. Cessation of smoking has been found very effective in reduction of the risk of development of type 2 diabetes mellitus. Socio-economic impact on smoking cessation has been reduced and resulted in improvement in the type 2 diabetes mellitus therapy (30, 31). It has been reported in some literatures that individuals during their teenage begin abusing tobacco and cigarettes after getting diagnosed with type 2 diabetes mellitus, thus, it has become very important to screen the adolescents for tobacco abuse and their appropriate cessation

Current therapies

Many healthcare providers are inclined to the standardized approaches for their patients. Thus to rule the controversies out, American diabetes mellitus association (ADA) has designed standard guidelines for evidence based evaluation for the treatment of patients with type 2 diabetes mellitus (32). Currently, treatment choices for type 2 diabetes mellitus include biguanides, meglitinides, TZDs, Sulfonylurea, AGIs, DPP-4 inhibitors, insulins and GLP-1 agonists and the prophylactic strategies involve avoidance from addictive agents such as alcohols, tobacco, following of a healthy routine physical activity regime and a healthy balanced diet. However, there are several other treatment strategies are available that differ from region to region (4).

Classes of drugs mostly prescribed

By the year 1990, Biguanides, Sulfonylureas and insulins were limitedly available treatments meant for the pharmacotherapy of type 2 diabetes mellitus (33). In an observational study conducted by G. Caleb Alexander *et al*, it was found that population that were receiving treatment for diabetes in the year 2007, were provided with a diverse newer inclusion of drug categories (34).

Most namely of them were Biguanides (Metformin), Sulfonylureas, glitazones, Stagliptin (being the only DPP4i of the time), and the only incretin analogue of the time named Exenatide (34). They also found a reported reduction in the use of insulin (34). The lacuna of the prescription patterns were the economic burden as they have reported a rise in the cost of the prescription by 87% from 2001 to 2007 (34). They also found an increase in the usage of multi-drug therapy which made a sharp increase in the mean hypoglycaemic drugs from \$56 to %76 from 2001 to 2007 respectively (34). The reason for the rise in the cost of the prescriptions are due to the rise in the cost of the individual hypoglycaemic agents and therefore affecting the adherence behaviour of the patients. This to an extension can be responsible for their control over the glycaemic levels.

Necessary changes in lifestyle

To attain power over the metabolic reactions for a longer period of time, composition of both pharmacological and non-pharmacological approaches are of an absolute importance. Significant reduction in the HbA1c levels have been proved to reduce the vulnerability of developing macrovascular and microvascular complication (35). In the American Diabetes Mellitus Association (ADA)/EASD, it has been recommended that therapy should initially be approached using interventions in the lifestyle, which has been proven very beneficial. However, the experiences differ within the individuals (36). The lifestyle interventions that are practiced currently include diet, Calorie intake, nutrition intake, carbohydrate balance. Physical activities such as exercises have been reported to

prove beneficial for the patients suffering from type 2 diabetes mellitus in declining their co-morbidities such as retinopathy and neuropathy (37). However, the exercises should only be carried out in the absence of ulcers or lesions in the lower parts of the body, as, due to the presence of high blood glucose, the wound tends to worsen (38). With the synergistic effects seen with physical exercise with the use of hypoglycaemic drugs, care should be taken with respect to the carbohydrate intake with considerable optimisation of drug doses. Moderate physical activity and exercise are prescribed to bring good results in glycaemic control and neuropathy, however, as a drawback to prescriptions, it develops painless ischemia, increasing mortality and thereby demanding cardiovascular screening in advance (39).

Drawback of current prescriptions

The broad variety of the hypoglycaemic medication that are currently under use, possess many adverse effects. The increase in the cost of individual drugs are resulting in a socio-economic burden to the patients receiving the prescriptions. The need for effective management and optimisation of the prescription patterns and adherence to the regulatory guidelines are of vital importance (3). Rational approaches to treat diabetes by introducing lifestyle interventions and inclusion of other non-pharmacological interventions are necessary for gaining control over the glyated haemoglobin levels in the individuals that are suffering from type 2 diabetes mellitus (40).

Table 1: Demographic variables showing sleep deprived and diagnosed T2DM Population.

Age	20-39	40-59	≥59
Percentage Sleep deprived	37%	40%	35.30%
Percentage that developed T2DM	3.20%	13.5	26

Table 2: Demographic variable showing gender-wise prevalence of Type 2 diabetes and sleep deprived in American Population.

Gender	Percentage diagnosed with diabetes	Percentage of undiagnosed diabetic patients	Total percentage	Percentage of Population having ≤7 hours
Female	9.20%	2.50%	11.70%	35.50%
Male	9.40%	3.40%	12.70%	34.80%

Table 3: Individual prevalence of each factors resulting in sleep disturbances and development of diabetes

Health risk factor	Definition	Short Sleep (>7 Hours)	Sufficient (≥7 Hours)
		Percentage	Percentage
Obese	BMI ≥30 kg/m ²	33%	26.50%
Physically inactive	No leisure time physical activity in past 30 days	22.20%	20.90%
Current smoker	Currently smoke cigarettes every day or some days	22.90%	14.90%
Excessive alcohol	Underage drinker, binge drinker, or heavy drinker	19.40%	19.10%
Diabetes	Population that developed diabetes due to insufficient sleep	11.10%	8.60%

SUMMARY & CONCLUSION:

The global prevalence of diabetes mellitus is increasing exponentially. Out of them, the majority of the population are developing type 2 diabetes mellitus due to various factors, either pathological or socio-economic impact. The need for addressing the situation has raised many queries among the physicians and healthcare practitioners as even the most effective pharmacological treatments that are available in the market are not sufficient enough to endure the optimum glycaemic control among the diabetic population. The large variety of the anti-hyperglycaemic drugs that are currently prescribed to the patients suffering from type 2 diabetes mellitus have raised questions in terms of selecting the appropriate strategy to be inculcated for the reason based prescription and the best maintenance of HbA1c levels. The Glycated Haemoglobins assay has brought a vibrant change in the therapeutic management of type 2 diabetes mellitus as it helps in the predictive approaches for approximately three months for the treatment.. The change in the environmental conditions and the work-life balance are creating various changes in the body's normal physiology, which is affecting the internal metabolic cycles that are essential for homeostasis. The most important of them have been found that the biological and circadian rhythms are getting broadly affected resulting in the alterations of the sleep wake cycle. As a result, there are changes that take place inside a human body where the impact to the essential metabolic functions are negative. In this review it has been found that studies and surveys available across the literatures provide a positive relationship between lack of sleep or alterations in the sleep wake tie develop insulin resistance among the working youth, due to which there is a high prevalence for them to develop type 2 diabetes mellitus. On the other hand, the modifications in the food patterns across the regions differ on the basis of their availability and the ethnic cultures. However there is a sharp rise in the consumption of refined and fast food which are leading to a very high prevalence of obesity. Obesity in-turn leads to a cascade of development of various other chronic diseases, in-light of lifestyle diseases namely, cardiovascular diseases, hypertension, and obesity also leads to development of insulin resistance. Obesity has been found to be a global threat and has been a major factor for economic burden in many countries. The increased intake of sweetened beverages and aerated fizzy drinks have increased the prevalence of diabetes among the youth and the middle aged population. Also lack of balance between the nutrition is leading to imbalance in the maintenance of glycated haemoglobin levels. The depravation from sleep and the altered food pattern has synergised the loss of control of HbA1c levels among type 2 diabetes mellitus. Furthermore the increase in the substance abuse by adolescents and youth are leading to an increase in the prevalence of type 2 diabetes mellitus.. This review suggests the various factors and variables that can be intercepted, treated and even be modified in order to achieve maximum efficiency in the management of type 2 diabetes mellitus. These interventions will also increase the effectiveness of the pharmacological therapy that are

currently being prescribed for the purpose of curing diabetes. This review also suggests adherence to some of the guidelines established by the ADA that recommends the optimum utilisation of the prescribed medication. It is always preferable for undertaking the non-pharmacological approaches discussed in the review such as living an active life, avoidance from substance use and necessary steps to be taken to control obesity and body mass index over the available pharmacological treatments, to enhance the overall management of type 2 diabetes mellitus with minimum ill effects of the drugs.

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