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Lifestyle Diseases: Early Detection and Management

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Abstract—
Lifestyle diseases are caused due to health damaging choices that one makes in their day-to-day life. The onset of these diseases is insidious, they take years to develop, and once encountered do not lend themselves easily to cure.
Lifestyle diseases are non-communicable diseases (NCDs). Four major types of NCDs are cardiovascular diseases, diabetes, cancer and chronic respiratory diseases. Risk factors such as a person's background, lifestyle and environment are known to increase the likelihood of certain noncommunicable diseases. They include age, gender, genetics, exposure to air pollution, and behaviors such as smoking, unhealthy diet, and physical inactivity which can lead to hypertension and obesity, in turn leading to increased risk of many NCDs. Most NCDs are considered preventable because they are caused by modifiable risk factors. An early detection means offering treatment at a more favorable stage or taking action to prevent the disease. It is essential to have a coordinated, strategic prevention approach that promotes healthy behavior, helps early detection and diagnosis of disease, supports people of every age and eliminates health disparities. A Preventive Health Checkup aims to identify and minimize risk factors in addition to detecting illness at an early stage. Ongoing cuttingedge multidisciplinary research in textile fibers, biomedical sensors, and wireless and mobile telecommunications integrated with telemedicine, aims at developing intelligent biomedical clothing (IBC) that could pave the way to support personalized management of health and diseases at the point of need and at any time. Activity monitoring of a person for a long-term would be helpful for controlling lifestyle associated diseases. Home Healthcare Monitoring Framework manages lifestyle diseases using long-term activity monitoring. The framework recognizes the user's activities with the help of the sensed data in runtime and reports the irregular and unhealthy activity patterns to a doctor and a caregiver. The framework has a hierarchical structure that consists of four layers: activity classification layer, activity pattern generation layer, disease inferring layer and application layer.
Keywords—*lifestyle diseases, non-communicable diseases, risk factors, biomedical sensors, intelligent biomedical clothing, activity recognition, long-term activity monitoring, healthcare monitoring framework*

I. INTRODUCTION

Lifestyle diseases are ailments that are primarily based on the day to day habits of people. An unhealthy and irregular standard of living influences the risk of such diseases in the later part of one's life. The symptoms and the initial signs of these diseases are common to the people with irregular lifestyle. Habits that detract people from activity and push them towards a sedentary routine can cause a number of health issues that can lead to chronic non-communicable diseases that can have near life-threatening consequences. Because of the current lifestyle, food habits, lack of exercise, and stress, people are becoming more vulnerable to many diseases like diabetes, hypertension, dyslipidemia, coronary artery disease and malignancies. Early detection of disease in its latent phase helps in timely therapeutic interventions, thereby significantly reducing the morbidity, mortality and economic burden due to the disease. Lifestyle diseases manifest in the form of non-communicable diseases.
Non communicable diseases (NCDs) are chronic in nature and cannot be communicated from one person to another. They are a result of a combination of factors including genetics, physiology,

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environment and behaviors. The main types of NCDs are cardiovascular and chronic respiratory diseases in addition to cancer. NCDs such as cardiovascular diseases (CVD), stroke, diabetes, and certain forms of cancer are strongly linked to lifestyle choices, and hence, are often known as lifestyle diseases. NCDs are caused, to a massive extent, by four behavioral risk factors: tobacco use, unhealthy diet, insufficient physical activity and harmful use of alcohol. The causes of NCDs can be divided into three broad categories: modifiable behavioral risk factors, non-modifiable risk factors and metabolic risk factors.

A. Modifiable behavioural risk factors

Behavioural risk factors such as excessive use of alcohol, bad food habits, eating and smoking tobacco, physical inactivity, wrong body posture and disturbed biological clock increase the likelihood of NCDs. The modern occupational setting (desk jobs) and the stress related to work is also being seen as a potent risk factor for NCDs.

B. Non-modifiable risk factors

Risk factors that cannot be controlled or modified by the application of an intervention can be called non-modifiable risk factors and include age, race, gender and genetics.

C. Metabolic risk factors

Metabolic risk factors lead to four major changes in the metabolic systems that increase the possibility of NCDs which are: increased blood pressure, obesity, increased blood glucose levels or hyperglycaemia, and increased levels of fat in the blood or hyperlipidaemia.

An important way of controlling non-communicable diseases is by controlling the risk factors associated with it. In other words, a number of non-communicable diseases can be prevented by early detection; thereby, controlling the behavioural or lifestyle habits associated with those diseases. A number of solutions that can be implemented by the government and other involved groups to reduce the common modifiable risk factors.

II. TYPES OF LIFESTYLE DISEASES

A. CVD

Cardiovascular diseases are a group of disorders of the heart and blood vessels and may include: ischaemic heart disease, stroke, peripheral arterial disease, and congenital heart disease.

Major Modifiable Risk Factors	Non-Modifiable Risk Factors	Other Risk Factors
High blood pressure Abnormal blood lipids Tobacco use Physical inactivity Obesity Unhealthy diet (salt) Diabetes Heavy alcohol use	Age Heredity or family history Gender Ethnicity or race	Excess homocysteine in blood - Inflammatory markers (Creactive protein) Abnormal blood coagulation (elevated blood levels of fibrinogen) Lipoprotein(a)

B. Diabetes

Diabetes is a metabolism disorder that affects the way the body uses food for energy and physical growth. There are 4 types of diabetes: Type 1, Type 2, Gestational, and Pre-Diabetes (Impaired Glucose Tolerance). Type 2 is the most common diabetes in the world and is caused by modifiable behavioural risk factors.

Major Modifiable Risk Factors	Non-Modifiable Risk Factors	Other Risk Factors

Unhealthy diets Physical Inactivity Obesity or Overweight High Blood Pressure High Cholesterol Heavy alcohol use Psychological stress High consumption of sugar Low consumption of fibre	Advanced age Family history/ genetics Race Distribution of fat in the body	Presence of autoantibodies Low socioeconomic status

C. Cancer

Cancer affects different parts of the body and is characterised by a rapid creation of abnormal cells in that part and can invade other parts of the body as well. More than 7 million people die of cancer each year and 30% of those diseases are attributed to lifestyle choices.

Type of Cancer	Modifiable Risk Factors	Other Risk Factors
Cervical cancer	Smoking Poverty Human papilloma virus infection	Immune deficiencies Family history
Lung cancer	Smoking Second hand smoke Radiation therapy Being exposed to asbestos, radon, chromium, nickel, arsenic, soot, or tar Living in air-polluted place	
Breast cancer	Hormone therapies Weight and physical activity	Race Genetics BRCA1 and BRCA2 genes Age
Prostate cancer	Obesity Bad food habits Low intake of fibre	Age Race
Colorectal cancer	Unhealthy diet Insufficient physical activity	Age Race
		Family history Diabetes

D. Chronic respiratory diseases

Some of the most under-diagnosed conditions, chronic respiratory diseases (CRD) are a potent cause of death globally with 90% of the deaths taking place in low-income countries. Chronic obstructive pulmonary disease (COPD) and asthma are the two main types of CRDs.

Modifiable Risk Factors	Non-Modifiable Risk Factors
Cigarette smoke Dust and chemicals Environmental tobacco smoke Air pollution Infections	Genetics Age

III. PREVENTIVE HEALTH CHECKUP

The key to early detection of lifestyle diseases is to perform regular preventive healthcare checks with the help of screening tests. A screening test is done to detect potential health disorders or diseases in people who do not have any symptoms of disease. The goal is early detection and lifestyle changes or surveillance, to reduce the risk of disease, or to detect it early enough to treat it most effectively. Screening tests are not considered diagnostic, but are used to identify a subset of the population who should have additional testing to determine the presence or absence of disease. It is evident that a significant number of disease states can be identified by preventive health checkups. People can be encouraged to utilize preventive health services for early detection of disease states and adopt timely interventions in this era of increasing lifestyle diseases.

With advancements in biomedicine and sensor technology, health check-ups can be performed using portable biomedical sensors.

IV. INTELLIGENT BIOMEDICAL CLOTHING

The new generation of biomedical sensors present a large spectrum bandwidth allowing new measurements on human and new approaches for diagnosis, ambulatory healthcare, care at home and at the point of need, anytime.

Non-invasive sensors are the most challenging and advantaged to monitor physiological functions but also daily activities and individual behaviour, offering painless measurement, comfort and prevention from infections and contamination. The wearable non-invasive sensors can be applied in contact with or near to the body and measure an impressive number of body parameters such as vital signs (ECG, pulse, blood oxygen saturation, respiration, skin temperature, blood pressure, CO2), body kinematics as well as sensorial, emotional and cognitive reactivity such as EMG, posture, fall, movement, speed, acceleration and pressure. The wearable devices benefit today from significant progress in system integration and miniaturisation and can be applied in different body locations, e.g. wrist and abdomen. However, such wearable can cover only a specific (and generally small) body measurement area and cannot fulfil, alone, all the needs for sensing, actuating, displaying, interacting with the user and communicating. These shortcomings are overcome by intelligent biomedical clothing.

Intelligent biomedical clothing refers usually to clothes with sensors that are close to or in contact with the skin. The sensors are enclosed in the layers of fabric, or it is the fabric itself that is used as the sensors. Such sensors can be piezo-resistive yarns, optic fibres, and colored multiple layers. IBCs have several advantages, starting with removing the task of placing the sensors by a nurse or a physician, providing a “natural” interface with the body. Commonly, IBC is understood as the integration, into textile, of sensors, actuators, computing, and power source, with the whole being part of an interactive communication network. Such systems could only be conceived through a combination of recent advances in fields as diverse as polymer and fibre research, advanced material processing,

microelectronics, sensors, nanotechnologies, telecommunication, informatics, biochemistry, and medicine.

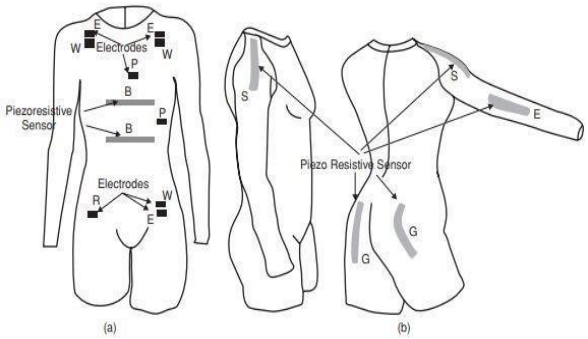

Fig. 1. Textile sensor prototype model (a) Front (b) Side and back

V. HOME HEALTHCARE MONITORING FRAMEWORK

Advancements in sensor technologies give us the opportunity to recognize activities of daily living (ADLs) for a long-period of time. Long-term activity monitoring could be helpful for the caregivers or doctors to monitor user's unhealthy and irregular activity patterns. This not only can reduce the cost of healthcare but also can avoid unwanted consequences.

Monitoring a person's lifestyle over a long period of time can be helpful for the following purposes: *Early identification of the lifestyle:* A person is generally at risk of a lifestyle disease when he/she lives his/her life in a certain style. Moreover, initial signs and symptoms of such diseases appear in people with irregular life patterns. By long term activity monitoring, it would be possible to identify such styles (e.g., irregular and unhealthy) and determine the risk of the disease before the actual disease appears.

Prevention of lifestyle diseases: It would be possible to prevent a disease at the first place with the identification of the lifestyle. A healthy lifestyle and physical activity help prevent obesity, heart disease, hypertension, diabetes, colon cancer, and premature mortality. A person can assess his/her lifestyle and become aware of any irregular patterns though monitoring daily activity patterns. *Management of lifestyle diseases:* A person who has a lifestyle disease should make changes to assure a healthy lifestyle. For example, there is no cure for type 2 diabetes, but it can be effectively controlled by maintaining normal blood-glucose levels. This can be achieved through weight control by following a nutritious and balanced diet, along with regular and stringent exercise.

The framework can produce a significant amount of information to assist the medical practitioners in not only diagnosing a lifestyle disease but also to prevent it. The key idea of the framework is that it would monitor target activities that reflect the initial signs and symptoms of lifestyle disease. Since lifestyle diseases appear in people with irregular life patterns, it can predict the risk of the diseases by monitoring the target activities for a long-period of time.

The framework has a hierarchical structure that consists of four layers:

1. activity classification layer
2. activity pattern generation layer
3. disease inferring layer
4. application layer

In the activity classification, target activities are recognized using an activity recognition technique. In the activity pattern generation layer, a regular pattern of each target activity is generated by adopting a statistical modelling approach. Finally, in the disease inferring layer, the risk of lifestyle disease is measured based on the similarity between the daily activity pattern and a predefined disease symptom pattern. In the web-based application layer, the user's current activity, activity pattern, and risk of disease are reported to medical practitioners.

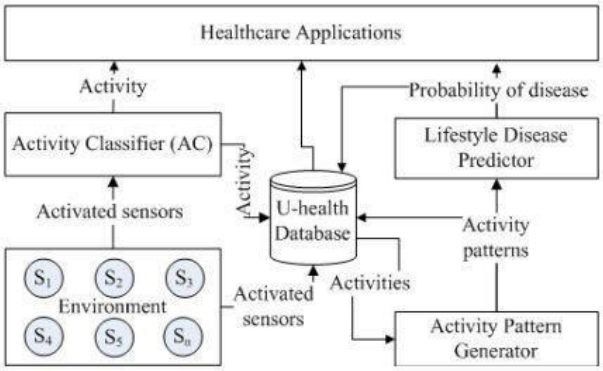

Fig. 2. Overall architecture of the proposed healthcare framework.

The main idea behind the disease inference is to observe the irregularities of the user's daily activities. There could be different types of irregularities of the activity patterns, for example, the frequency of doing an activity is more or less than the usual, the means of doing an activity is not appropriate, or there exists a mismatch of the sequence of activities. For this version of the framework, we have used the frequency of an activity as the primary source for disease inference.

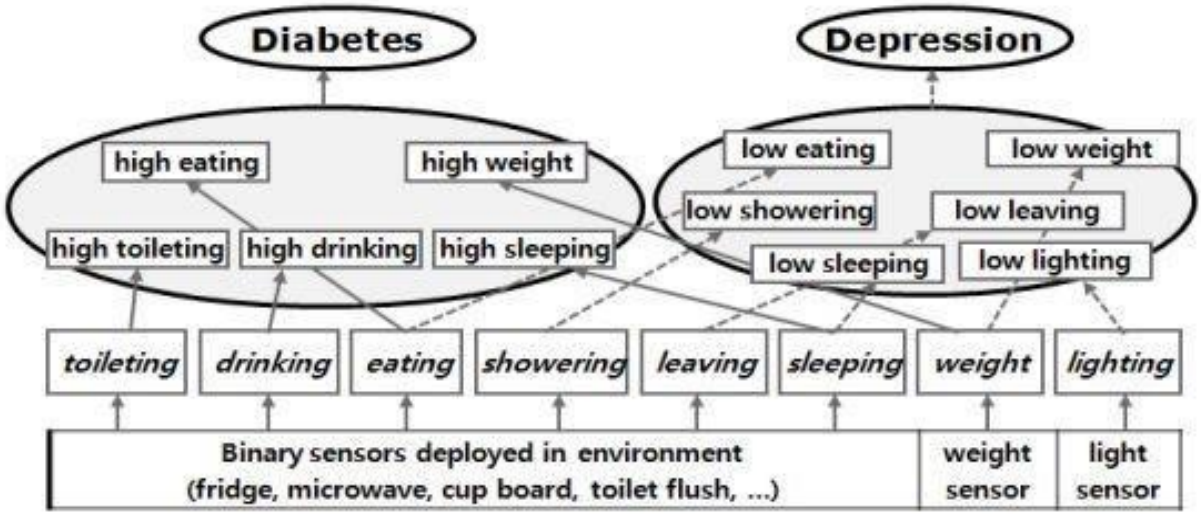

Fig. 3. Lifestyle disease inference model

The overall architecture of the proposed framework is illustrated in Figure 1. It consists of three hierarchically connected modules: activity classification, activity pattern generation and lifestyle disease prediction. The activity classification module is used to recognize the user activity in realtime and provides its output to the activity pattern generation module. The activity pattern generation then determines various parameters such as, daily activity frequency, regular activity frequency, graded activity frequency and daily activity pattern and provides output to the lifestyle disease prediction module. The lifestyle disease prediction module then determines the risk of a lifestyle disease.

The results of the lower level modules are the inputs to the higher level modules. The output of each module are stored in the activity database for providing various healthcare information such as current/last activity, activity frequency and duration, activity pattern, and disease probability. The framework also provides a web-based healthcare application for the clinician and caregiver to monitor the activity database remotely.

VI. CONCLUSION AND FUTURE WORKS

Solutions like Intelligent Biomedical Clothing and Healthcare Monitoring Frameworks can be helpful in early detection and management of lifestyle diseases.

For health monitoring, disease prevention and management, rehabilitation, and sport medicine, IBC may offer, in the mid-term future, a unique, wearable non-obtrusive platform for individualized services that is readily accessible and of good quality. Health monitoring systems in smart environments have evolved rapidly to become a viable alternative to traditional healthcare solutions. Long-term activity monitoring using healthcare monitoring frameworks could be helpful for managing lifestyle associated diseases.

The future development of integrated lifestyle monitoring frameworks based on full integration of sensors and biomedical clothing for long-term activity recognition could overcome existing barriers in early detection and management of lifestyle diseases and be a key enabler technology for disease detection, disease prevention, disease management, and overall lifestyle management.

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