2021 43rd Annual International Conference of the
IEEE Engineering in Medicine & Biology Society (EMBC)
Oct 31 - Nov 4, 2021. Virtual Conference

# Using Physiological Signals to Detect and Monitor Obstructive Sleep Apnea in Children with Down Syndrome

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***Abstract*— Down Syndrome (DS) is one of the most common genetic conditions in children. Due to anatomical features prevalent in those with DS, their risk of developing obstructive sleep apnea (OSA) significantly increases. Current devices for detecting OSA are not designed or suitable for children, let alone those with DS. This research evaluated whether physiological signals can be used to detect disturbed breathing in children with DS. During this pilot study, physiological signals were measured on a participant without DS to determine reference patterns and the most minimally invasive procedures. Signals that were included are electrocardiograms, electromyograms, pulse, and respiration patterns. The electromyogram offered the highest sensitivity (98%) of detecting both regular and stopped breathing. Through monitoring and detection of obstructive sleep apnea, this research aims to preserve the cognitive abilities, quality of life, and overall health of children with DS.**

***Clinical Relevance*—This research aims to increase awareness of OSA in children with DS. OSA is often left undetected by parents, and because of underlying heart problems in those with DS, there is a higher risk for health complications.**

## I. INTRODUCTION

Obstructive sleep apnea (OSA) is a syndrome that occurs during sleep caused by the lack of airflow due to complete or partial obstruction, collapse, or narrowing of the upper airways [1]. Uncommon in the general pediatric population, up to 100% of children with Down Syndrome (DS) can have abnormal sleep studies and are at a higher risk for developing this condition due to differences in anatomy and overall health [2]. The current gold-standard method for detecting OSA is polysomnography. However, it requires attended overnight tests and is uncomfortable for patients, making it less than ideal for children with DS. Current methods for detecting and monitoring sleep apnea are not designed for the anatomical and behavioural features prevalent in those with DS. The purpose of this research is to evaluate which signals can best detect OSA in children with DS.

## II. METHODS

The participant (F, 21 years old) laid on their back and surface electrodes for a single lead electrocardiogram (ECG) and electromyogram (EMG) were placed on the intercostal region and the diaphragm respectively to detect breath variations. A photoplethysmogram (PPG) sensor was placed on the right index finger to detect variation in pulse and an accelerometer was placed on the left side of the chest to measure acceleration in the y-axis. Breath holds were designed to resemble an apneic episode typically lasting between 10 s and 30 s. Data was recorded using BIOPAC and Arduino, and was analyzed in MATLAB through moving averages.

## III. RESULTS

Fig. 1 shows both the raw and the moving average results of the initial test. The moving average indicates the detection of stopped breathing with clear flatlines in the data between 80 s to 100 s and 120 s to 140 s. This test was repeated for a total of 15 sessions (5x over 3 days) to conduct inferential statistical analyses, determining the sensitivity of the stopped breathing detection.

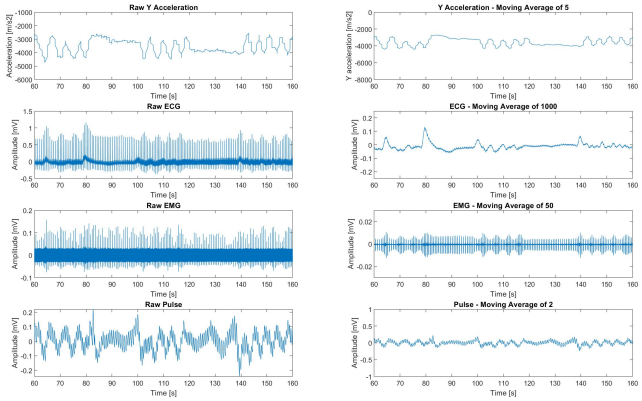


Figure 1. Raw data and moving average results for the first completed test trial including accelerometer, ECG, EMG, and PPG results.

## IV. DISCUSSION & CONCLUSION

Four non-invasive physiological signals were investigated and concluded to have an accurate representation of stopped breathing, resembling an apneic episode in individuals with OSA. PPG offered the least consistent results, while acceleration, ECG and EMG offered reliable findings. Further direction for this research includes measuring physiological signals on additional participants without DS, and performing variations in breath holds to determine reference patterns and confirm the most minimally invasive procedures. The final step will include testing on children with DS and creating a child-friendly device designed to suit the anatomy and behavioural characteristics of children with DS.

## REFERENCES

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