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Zhang Y[1], Wang D[1], Timm G[1], Erdman A[1]
***1.** University of Minnesota*

URINE LEAKAGE DETECTION IN FEMALE ATHLETES DURING PHYSICAL ACTIVITIES

<u>Hypothesis / aims of study</u>
Urinary incontinence (UI) occurs because of problems with connective tissues, muscles and nerves that help to hold or release urine. It currently affects over 13 million Americans with the majority being females. UI is more common in post-menopausal and multiparous women, however recent studies have also shown an unexpected high occurrence of UI among young physically fit female population who are actively participating in intensive activities [1-3]. Those findings indicate a need to explore the relationship between daily intensive exercise and the suffering of UI. An ambulatory device has been developed to record urological response to the intensity of the forces that the body is subjected to during athletic activities in the presence of motion noise and perspiration interference. The urinary leakage detector (ULD) is one of the three sensors in the ambulatory device and is able to be employed to detect urine leakage of female athletes during their physical activities.
<u>Study design, materials and methods</u>
The device consists of three wearable wireless sensors including a tri-axial accelerometer (+/-25g), a biaxial inclinometer (360^o) and a urinary leakage detector that communicates wirelessly with a wearable pocket data logger as shown in Fig. 1(a). The features of low power consumption and large memory size allow for 3 hours' of data logging without interruption. The accelerometer and inclinometer enable us to determine the intensity of physical activities based on the force level and direction developed in the body when urinary leakage occurs. The device is small, lightweight, battery powered and non-invasive and can be worn comfortably by females on their wrists or belts. Those sensors are placed on the low back as shown in the Fig. 1(b).

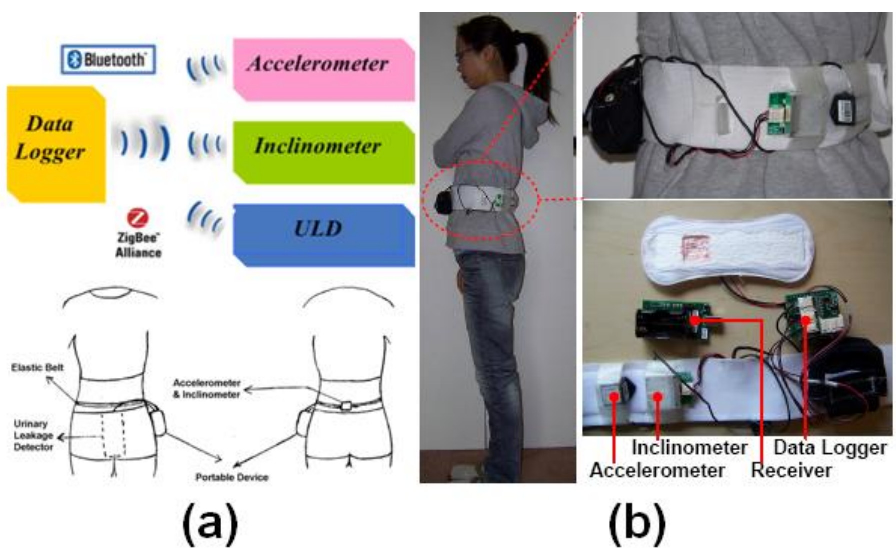

Fig. 1: (a) Schematic drawing and (b) photo of the ambulatory device design and its placement.

The uniquely designed urine leakage detection sensor features resistance to both motion noise and perspiration interference. The center of the ULD is a resistance sensing area which consists of four 1 cm by 1 cm sensors made of etched PCB board. Those sensors are glued on to a highly absorbent pad. This sensors are then embedded in, but insulated from, a regular pantiliner A with the size of 15 cm by 8 cm, such that the sensor area does not slip away even during intense activities. On the top of pantiliner A, another same sized pantiliner B carved with a window corresponding to the position of sensor window is used to cover the bottom layer. In such a design, the electrodes are located in a reservoir and thus are prevented from contacting the skin, which is essential to reduce the motion noise.
<u>Results</u>
Division I athletes from the University of Minnesota were recruited to participate in the urine leakage detection study with the ambulatory device according to the research protocol approved by the Institutional Review Boards (IRBs) of the University of Minnesota. Each athlete participated in 3 to 4 tests and each test was roughly 30 to 45 minutes long. Antiperspirant was placed on the athletes upper thighs to minimize the amount of noise due to perspiration accumulation on the urinary leakage device. The device was attached to the athlete by an elastic belt around her waist as shown in Fig. 1(b) and a pad was placed in the underwear of the athlete. The pad had 4 sensors which were able to detect fluid leakage from the athlete as she ran. Data was gathered continuously by a wireless transmitter which automatically recorded the data into an excel file for later analysis. The pads' weight was recorded both before and after the experiment was conducted so the total amount of fluid leaked from the athlete was recorded.
A graph of the voltage vs. time is shown in Fig. 2. The weight difference of the pantiliner before and after this test was 16.0g. Two urine leakage events were reported by the subject during the test which occurred at 17min 54 sec and 27 min 7 sec as shown on the ULD recordings in Fig. 2.

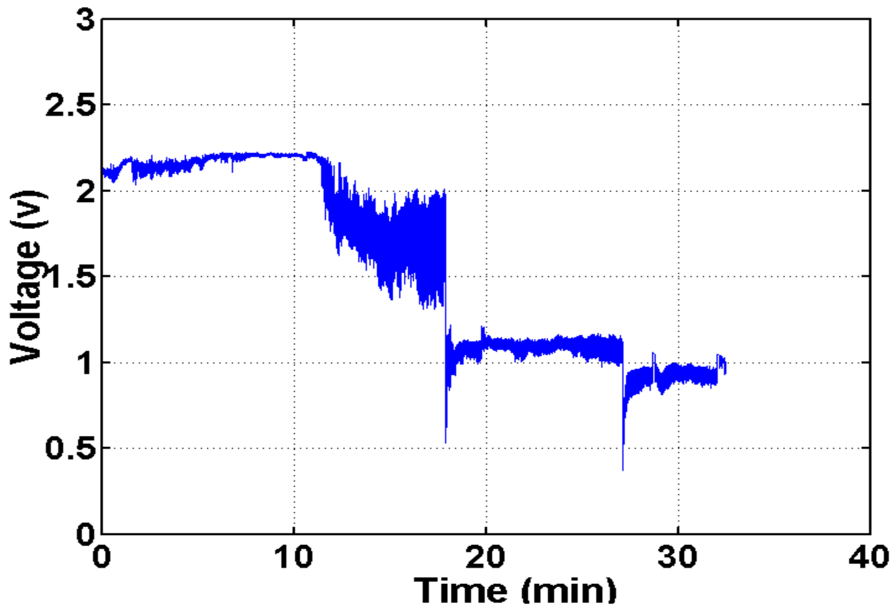

Fig. 2: Recordings of urine leakages of a female athlete during her running.

Interpretation of results

A sizeable amount of noise caused by the perspiration of the subject started to be recorded at 11 min 28 sec during her long-time running, as shown in Fig. 2. This noise could be more significant with subjects who perspire more profusely or during more intensive activities. Fortunately, our ULD sensor can clearly differentiate between the perspiration noise pattern and the pattern corresponding to urine leakage. As shown in Fig. 2, the voltage change caused by urine leakage causes a deep drop in voltage, and the pattern is distinctly different from the artifactual signal produced by perspiration.

Concluding message

Results demonstrate that the urine leakage detector we developed can be used to successfully detector urine leakage of female subject during their physical activities, even in the cases of very intensive activities or in presence of profuse perspiration. The portable urine leakage detector is a useful tool in characterizing the relationship between daily and physical activities and the occurrence of UI.

References

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Is this a clinical trial?	**No**
What were the subjects in the study?	**HUMAN**
Was this study approved by an ethics committee?	**Yes**
Specify Name of Ethics Committee	**the Institutional Review Boards (IRBs) of the University of Minnesota.**
Was the Declaration of Helsinki followed?	**Yes**
Was informed consent obtained from the patients?	**Yes**