Proc. of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies, vol.7, issue 1, no.18, 2023

# A Data-Driven Context-Aware Health Inference System for Children during School Closures

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UBICOMP ISWC 2023 CANCUN, MEXICO

## School closures due to pandemic influence children's health

- Since March 2020, more than 90% of schools have experienced **temporary closure** due to COVID-19
- Schools: critical settings for **physical activity** and essential sources of **mental health services**
- Parents' unawareness of the changes in their children's health

**Full-day face-to-face class**
**Before the COVID-19**

**Full-day online class**
**The outbreak of COVID-19**

**Half-day face-to-face and half-day online class**
**When COVID-19 was under control**


## Disadvantages of traditional methods for health monitoring

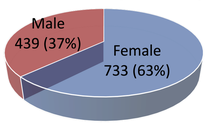
- Regular consultation
  - expensive, time-consuming, limited medical resources
- Self-testing

**Clinical scales**
- Each scale target to a specific health issue
- Require specialized expertise to interpret

**Wearable devices**
- Records not well interpreted
- Lack of evaluation of mental health
- Unaffordable for low-income families

## Dataset Description

**Participants:** primary or secondary school students in Hong Kong




- N = 1,172
  - Age: 6-18
  - Mean: 12.48
  - Standard deviation: 2.21

### Data Collection Periods

- **T0:** before the outbreak of COVID-19 (Sep 2019 - Jan 2020)
  - **L0: full-day face-to-face class**
- **T1**: full-day school closures due to COVID-19 (Mar 2020 - Apr 2020)
  - **L2: full-day online class**
- **T2:** half-day school reopening when COVID-19 was under control (Oct 2020 - Nov 2020)
  - **L1: half-day face-to-face and half-day online class**
- **T3:** after long-term half-day face-to-face classes (Oct 2021 - Jan 2022)
  - **L1: half-day face-to-face and half-day online class**

### Data Collected

- **Demographics**

| Age | Gender | BMI | BFP | Grades |
|---|---|---|---|---|

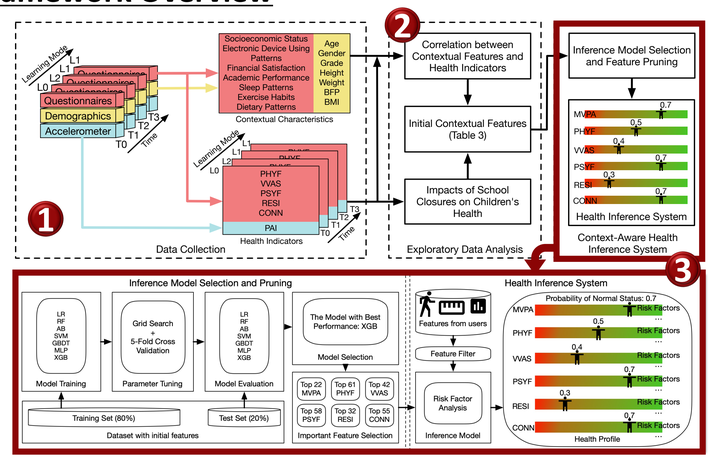
- **Tri-axial accelerometer data**
  - Mean wear days: 13.85 days
  - Standard deviation: 6.94 days

➢ ActiGraph wGT3X-BT worn on the wrist

- **Questionnaires**

| *Contextual characteristics* | *Widely used scales in clinical trials and population studies worldwide* |
|---|---|
| Socioeconomic status | **PedsQL**: Pediatric Quality of Life |
| Electronic device usage patterns | **EQ5D**: health-related quality of life |
| Financial Satisfaction, Academic performance | **Connor-Davidson Resilience Scale (CD-RISC)**: resilience |
| Sleep patterns, Exercise habits, | **Revised Resnick Social Connectedness Scale (RSCS)**: |
| Dietary patterns | Connectedness |

## Framework Overview




### 1. Data Collection

- Derive the contextual characteristics and six health indicators
  - **MVPA**: physical activity intensity
  - **PHYF**: physical functioning
  - **VVAS**: self-rated health
  - **PSYF**: psychosocial functioning
  - **RESI**: resilience
  - **CONN**: connectedness

### 2. Exploratory Data Analysis

- The impact of school closures on children's health
- The correlation between contextual features and health indicators

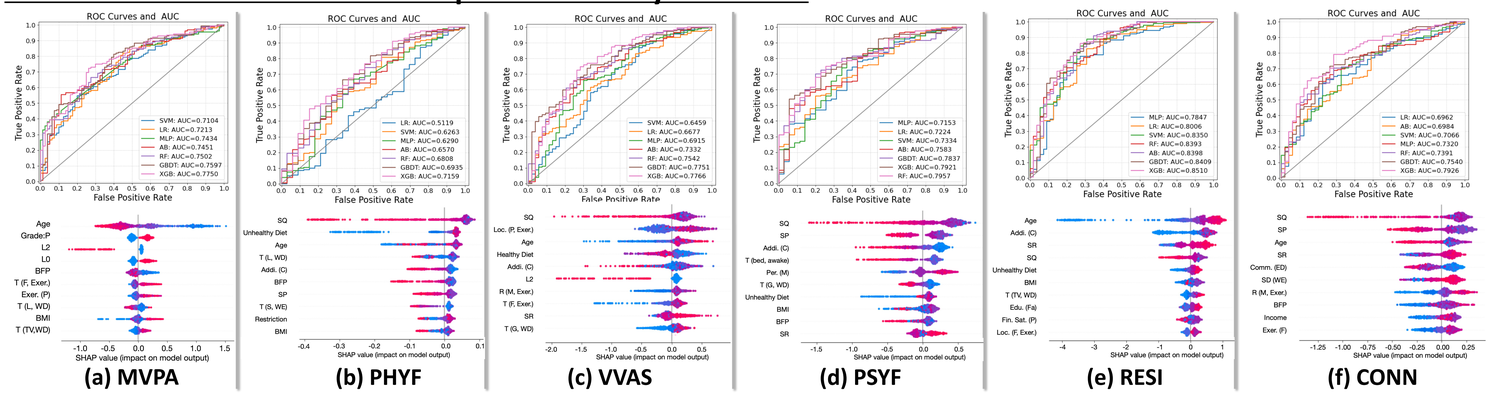
### 3. Context-Aware Health Inference System

- Select the model with the best performance
- SHAP-based feature importance analysis and feature pruning
- Risk factor analysis based on the optimal model
- Visualize the inference results and risk factors

## Exploratory Data Analysis Results

| Indicator | Impact of School Closures on Health Indicators | Correlation between Contextual Features and Health Indicators |
|---|---|---|
| **MVPA** | Half-day or full-day closures significantly **increase**⬆ ***SB*** and **decrease**⬇ ***MVPA*** Influence: full-day closures **>** the half-day | **Female < male, secondary < primary** Worse with increasing age, more electronic device usage, etc. |
| **PHYF** | Full-day closures significantly **worsen**⬇ ***female*** children's PHYF **Improved**⬆ after the reopening | **Female < males, secondary < primary** Worse with higher BFP, worse exercise patterns, dietary patterns, etc. |
| **VVAS** | The full-day closures significantly **improved**⬆ the VVAS of ***secondary school students*** | **Secondary < primary** Worse with worse sleep and exercise patterns, worse dietary habits, etc. |
| **PSYF** | ***Female*** children's PSYF significantly **improved**⬆ after the outbreak of COVID-19. | **Secondary < primary** Worse with worse academic performance, worse sleep patterns, etc. |
| **RESI** | School closures have **No** significant influence on children's RESI. | Worse with lower educated parents, lower financial satisfaction, etc. |
| **CONN** | Half-day closures **improved**⬆ the **secondary school students'** CONN This effect lasts after long-term half-day face-to-face classes. | **Secondary < primary** Worse with more time on electronic games, lower family income, etc. |

## Health Inference and Feature Importance Analysis Results




## Conclusion

- The **data-driven context-aware system** to *comprehensively* infer children's **physical and mental health status**.
- Evaluate the inference performance and conduct case studies based **on real-world datasets**.
- The **key findings**
  - Half-day school closures would be a **better** choice than full-day school closures.
  - Different influences of **objective financial conditions** and **subjective financial satisfaction**.
  - Electronic devices are a **double-edged sword**.
  - Good sleep, frequent exercise, and healthy diets are **panaceas**.
  - **Parents** should play an exemplary role.

**More details in the paper:**