Excessive use of electronic devices among children and adolescents is associated with musculoskeletal symptoms, visual symptoms, psychosocial health, and quality of life: a cross-sectional study.Materials and methods: This cross-sectional study aimed to evaluate the associations between electronic device use and the prevalence and severity of musculoskeletal symptoms, visual symptoms, psychosocial health, and quality of life in children and adolescents studying at primary and secondary schools.Data on the demographics, electronic device use of the adolescent participants, point prevalence and severity (expressed in terms of frequency and intensity) of musculoskeletal symptoms, visual symptoms, psychosocial health, and quality of life were measured and collected by questionnaire.Presence and frequency were assessed using a 4-point Likert scale (0 = "Never: The symptom/condition does not occur at all"; 1 = "Occasionally: Sporadic episodes or at most 1 time/week"; 2 = "Frequent: 2-3 times/weeks"; 3 = "Always: Almost every day/week"). For symptoms that were rated as being present, their intensity was assessed using a 3-point categorical scale (Mild = "You can feel the symptom, but it does not bother you"; Moderate = "The symptoms are bothering you and a break might be needed due to the symptom;" Severe = "The symptom bothers you so much that a treatment either by yourself or medical professionals is needed").To address these objectives, we sought to estimate: (1) the overall amount of electronic device use and symptom severity in samples of primary and secondary school students, and if they differed as a function of age/education level, and (2) the associations between device use and the prevalence and severity of a variety of symptoms and quality of life domains.Musculoskeletal discomfort index, eye discomfort index, and device-related psychosocial health index The responses to the questions assessing symptoms or problems in each of the above three domains were used to compute scores representing: (1) a Musculoskeletal Discomfort Index (MDI), (2) an Eye Discomfort Index (EDI), and (3) a Device-Related Psychosocial Health Index (DRPHI).Psychosocial health related to device use We also asked participants to indicate the presence and frequency with which: (1) they used an electronic device longer than originally intended, (2) others complained about the participant's electronic device use, (3) they attended school, (4) they perceived a negative impact of electronic device use on school performance, (5) they experienced sleep disturbance, and (6) were emotionally upset when not using electronic devices.Most children in the United States, United Kingdom, Singapore, China, Norway, Japan, and many other countries, exceed the 2-h daily screen time limit recommended by the American Academy of Pediatrics and the HKSAR Department of Health (7, 17, 18, 20-22).For example, very few studies have examined the role of device use on psychosocial health; even fewer have compared children in primary school and adolescents in secondary school regarding the prevalence and severity of symptoms associated with electronic device use.Recruitment procedure and data collection Study participants were recruited via the convenience sampling, from schools in Hong Kong that: (1) were registered under the Hong Kong Education Bureau, (2) offered Primary 5-6 or Secondary 1-4 education (i.e., grades 5-10), and (3) did not focus on serving children with special needs.Ethical consideration and confidentiality The study was approved by the Human Subjects Ethics Sub-Committee of the Hong Kong Polytechnic University (Reference Number: HSEARS20180604002).Demographics, frequency and duration of electronic device use, frequencies of musculoskeletal symptoms, visual symptoms, psychosocial health, and quality of life outcomes were

measured.Extended electronic device use was associated with increased prevalence and severity of musculoskeletal symptoms (?'s = 0.28–0.33, P's0.001), visual symptoms (?'s = 0.33–0.35, P's0.001), and poorer device use–related psychosocial health (?'s = 0.38–0.47, P's0.001).Most recently, perhaps due to the need to limit face–to–face activities because of Covid–19, the primary reason to use electronic devices has been shifting from entertainment to education, especially in economically privileged countries where e–learning has been incorporated into the school policy (3).Notably, research has shown that symptoms which develop in childhood and adolescence due to extended device use predispose those individuals to a higher risk of musculoskeletal and visual system disorders in adulthood (6, 25).We hypothesized that (1) more than 50% of the both study samples would report an average daily use greater than or equal to the recommended maximum of 2 h/day, (2) older participants would report more electronic device use and symptom severity than younger participants, and (3) more electronic device use would be associated with higher prevalence and severity of symptoms, and lower device–related psychosocial health and quality of life.The four musculoskeletal symptoms assessed were pain or aches, stiffness, or tiredness in the (1) neck, (2) shoulder, and (3) back regions, and (4) feelings of pins and needles or numbness in the upper limbs.The symptoms chosen for assessment were based on those associated with CVS (14), and included eye dryness, eye burning, eye itching, tearing, eye redness, eye pain, blurred vision, difficulty focusing for near vision, and double vision.The frequency and duration of device use in children and adolescents have increased drastically over the years and the study of its negative musculoskeletal, visual and psychosocial health impacts is necessary.Conclusion: Excessive electronic device use was associated with increased prevalence and severity of physical and psychosocial symptoms, and such use is more prevalent in adolescents when compared to the children.Other CVS symptoms include asthenopia, blurry vision, eye strain, and slow focusing, which are linked to the fatigue of visual system components (14).Evidence, most of which has been conducted in Western countries, has shown that the excessive device use is associated with sleep disruption, parental relationship problems, school performance problems, mental health problems, and daytime fatigue (2, 15–19).Measures Demographic variables and intensity of device use The questionnaire asked participants to provide information regarding their demographics (i.e., age, sex, and class year), and to indicate the average daily hours of electronic device use on school days and on holidays.Prolonged and frequent use of visual display units can lead to the development of Computer Vision Syndrome (CVS), which is associated with a set of specific symptoms, including burning sensations, dryness, and tearing in the eyes (14).Musculoskeletal–related symptoms Participants were also asked to indicate the presence, frequency, and intensity of four musculoskeletal–related symptoms during and/or after using electronic devices (Supplementary material).The findings have important health implications for children and adolescents, suggesting that early intervention is needed to reduce the risk of developing device use–related disorders.The inclusion criteria for the student participants are being: (1) a student in grades 5–10, (2) able to read and write Chinese or English, and (3) able to complete an online or hard copy version of the study questionnaire without assistance.A teacher in each school distributed a hard copy of the questionnaires or provided a link for participants to complete the questionnaire online, after explaining the purpose, process and ethical issues of the study.As a result,

the frequency and duration of electronic device use in adolescents has increased dramatically (4).A growing body of research has also been showing that the extended electronic device use is associated with numerous musculoskeletal symptoms including neck/shoulder pain, lower back pain, and arm discomfort (2, 3, 5–9).Vision–related symptoms The presence, frequency and intensity of nine visual symptoms were also assessed, using the same questions used to assess musculoskeletal symptoms.Primary 4–5 and Secondary 1–4 students were recruited from 3 schools in Hong Kong.Over 95% of adolescents aged 13–16 years owned their smartphones in 2018 globally and this figure has increased by 22% since 2014 (1).Electronic devices include smartphones, tablets, computers, and game consoles (2).These symptoms are known to be associated with reduced physical activity, increased medication use, and school absence in adolescents (10–12).Associations between the use of electronic devices and visual problems have also been reported (2, 3, 7, 13).Consent for their child's and adolescent's participation was obtained from the parents of the student participants who were