



Perspective

Is caries an independent risk factor for the child's psychomotor development? - A new insight to potentially shed the underlying mechanisms



Yen Chun G. Liu ^{a**}, Tien-Yu Shieh ^a, Andy Yen-Tung Teng ^{a,b*}

^a Center for Osteoimmunology & Biotechnology Research (COBR), Dept. of Oral Hygiene & School of Dentistry, College of Dental Medicine, Kaohsiung Medical University & University Hospital, Kaohsiung, Taiwan

^b Laboratory of Molecular Microbial Immunity, Div. of Periodontology, The Eastman Institute for Oral Health (EIOH), Department of Microbiology and Immunology, School of Medicine & Dentistry, University of Rochester Medical Center, Rochester, NY, 14620, USA

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Dental caries is characterized by penetration of oral microbiome into the hard tissues of tooth, producing either acute sequelae leading to irreversible decays on its structures (i.e., enamel/dentin and root) or chronic consequences resulting in functional deficits in oral cavity (i.e., pulpitis, missing teeth, occlusal instability and pain, etc.), where it constitutes one of the most prevalent illnesses with long-term burdens to humans; whereas, the experimental germ-free animals do not develop caries even in the presence of cariogenic diets.^{1,2} It is now clear that a relatively small group of strong acid-producing microbes, including *Streptococcus mutans* and

Lactobacillus spp. sufficiently increase the cariogenic risks in susceptible hosts.^{3,4} The etiologies involved in triggering and progressing to caries have been well-studied, including the substrate (host), diet, microbes/biofilm and time required for containing all risks surrounding our saliva. With the development of modern molecular and cellular microbiology and physiology, the causes-related biofilm and underlying mechanisms of caries have been studied down to the molecular levels for our understanding and managements.⁵

Children's growth involves both physical and mental developments. As caries may give rise to concerns on their health issues which remain unclear, our lab has been interested in studying whether severe caries may be implicated onto the child's general health and subsequent maturation; in particular, its relationship(s) to psychomotor development. To tackle this issue, we employed a designed sequence of cross-sectional analyses stemmed from the summed dmft scores indicative of the caries activity and the parallel measures of their psychomotor development [e.g., Chinese Child Development Inventory (CCDI), by quotients]⁶ to explore any potential

* Corresponding author. Center for Osteoimmunology & Biotechnology Research (COBR), College of Dental Medicine, Kaohsiung Medical University (KMU) & KMU Hospital, Kaohsiung, Taiwan.

** Corresponding author. Dept. of Oral Hygiene & Center for Osteoimmunology & Biotechnology Research (COBR), College of Dental Medicine, Kaohsiung Medical University, No. 100, Shih-Chuan 1st Rd, Kaohsiung, 80708, Taiwan

E-mail addresses: graceliuyc@gmail.com (Y.C.G. Liu), ytandyteng@gmail.com (A.Y.-T. Teng).

relationship in the preschooler cohorts randomly selected for study. Interestingly, it was recently found that there may be a positive relationship between caries activities and psychomotor development (i.e., personal-social and expressive language) in aged 4–6 children.⁶ Furthermore, when such caries scores were stratified using collected data from the rural township of central Taiwan whose average dmft was much higher (6.88 ± 5.17), compared to that from the southern cities of Taiwan whose averaged dmft was lower (4.07 ± 4.25 ;⁶), it became rather significant that when higher levels of caries were present, there was detectably lowered scales on psychomotor development as well (i.e., comprehension-concept, personal-social link and self-help; authors' unpublished data from communications). When such measures on the CCDI quotients were representatively depicted by "General Development Scales" to synoptically reflect the children's overall psychomotor development against the "differential" caries activities separately measured from the Southern cities (i.e., lower dmft scores detected in Tainan and Kaohsiung cities) and the Central rural areas of Taiwan (i.e., higher dmft scores detected in the Sin-Yi township of Nantou County) in preschool children (Fig. 1A), it is clear that there was indeed a good correlation, undiscovered previously, between severe caries and certain psychomotor measures (i.e., comprehension-concept, self-help and

personal-social) in aged 4–6 children.⁶ Notably, this is co-supported that, in our studies with higher vs. lower caries measured, their socio-economic status and the accesses to health-care and health-care facilities, vs. their nutritional status were comparable to those described in other areas/cities (authors' unpublished data from communications). Based on these results and analyses, we have herein further proposed a new and challenging hypothesis on caries in the growing children (Fig. 1B: a proposed scheme), if not properly treated or managed (e.g., as described in "National Dental Survey"⁷), severe caries may not only cause physical losses in the dentition, but result in or induce the sequelae accompanied by psychomotor deficits (i.e., personal language-communication to psycho-social interactions).

Comparably, a proposition opposed to the above hypothesis, "Is caries an independent risk factor for the child's psychomotor development? – A new insight to potentially shed the underlying mechanisms" must be accountably raised for such new ground-breaking perspective, based on scientific reasons. Yet, tooth decays, depending on severity or scales of involvement (e.g., low vs. high; Fig. 1A), may be implicated in the child's psychomotor development, which could manifest via personal interactions with the family or peers at school or community, producing certain negative influences on their learning (i.e.,

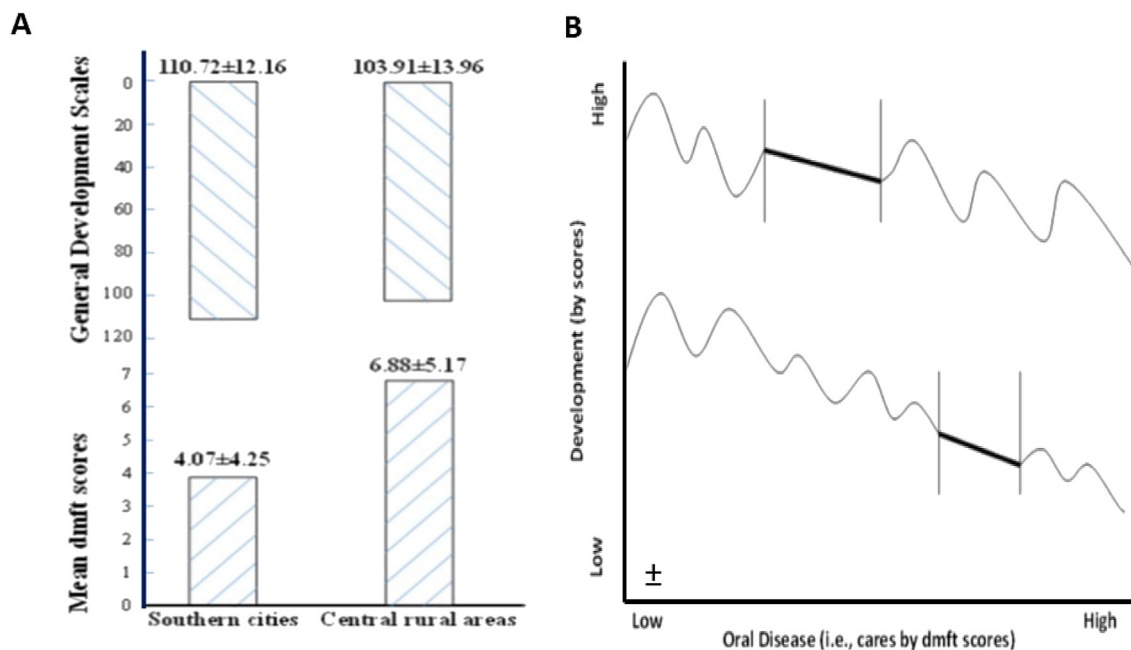


Fig. 1 The resulting bar-diagrams (in A) and a proposed scheme (in B) separately illustrating the likely reversed relationship between dental caries (by dmft scores) and psychomotor development (by General Development Scales of the CCDI quotients) in the preschool children investigated. A) The caries scores (dmft: 0–7) and the general developmental scales (scales: 0–120), as depicted separately from bottom-to-top on the Y-axis, were collected and measured from the Southern cities of Tainan and Kaohsiung (having lower dmft: 4.07 ± 4.25 vs. higher general developmental scales 110.72 ± 12.36) and the Central rural areas of Sin-Yi township in the Nantou County (having higher dmft: 6.88 ± 5.17 vs. lower general development scales 103.91 ± 13.96), as labeled from left to right on the X-axis, individually. Be noted that the p values shown indicate the statistically significant difference detected between the two groups (Southern cities vs. Central rural areas), using two-sample student t-test, where $p < 0.05$ was employed for comparisons. B) The solid-black lines depicted the potentially reversed correlation or link(s) between the various magnitudes of physical development (high vs. low by scores) and oral disease (i.e., caries, dmft scores), as illustrated. The gray-lines depicted the random episodes or events associated with different magnitudes on the disease scales or severity, as illustrated.

language expression, verbal skills & communications, etc.) or/and delays during their psycho-social maturations as well. Therefore, it must be deciphered and interpreted carefully whether "specific" influence from tooth decays is achieved "directly" (i.e., neurophysiologic paths) or "indirectly" (i.e., outside the neurologic circus) onto the psychomotor mechanisms, such as the behavior. Paradoxically, there may be out-lying behavioral factors (i.e., frequency of dentally related habits or diets, etc.) that could modify the manifests on personal communications and the magnitudes of developmental delays on language/verbal skills in the affected children.

Conceivably, when caries severity is high, children are likely to avoid chewing, reducing food-intake/swallowing and resulting digestive efficiency; later, it becomes more difficult to fulfilling their nutritional needs. It was reported that dietary fatty-acids may be associated with hyperactivity in children with learning disabilities⁸; thereby, the resulting visual, auditory, proprioceptive or vestibular dysfunctions when arise, the host's sensory neurons may not respond efficiently, leading to deficit in subsequent development, learning, or emotional maturity and stability.⁹ Nevertheless, the present stratified cross-sectional analyses described is consistent with our original speculation that a potential reverse-relationship between higher levels of caries (i.e., dmft 3–8; authors' unpublished data from communications) and psychomotor development may exist in the preschooler cohorts studied. Importantly, for the clinical applications, the underlying mechanisms, once revealed, will shed-lights on the scientific explanations for such critical new insight addressed above (Fig. 1B).

In summary, our present findings described in this "Perspectives", as the potential risk(s) being explored, could contribute to better understanding of its causes, which will be useful to translating into novel strategy for prevention. Critically, these new results suggest that such reverse-correlation(s) between caries and psychomotor development may arise through specific stages during children's growth, where the causal or risk(s), once identified, will facilitate to establishing better oral health-care programs and public policies, and to aiding the overall development for children; thereby, promoting the general health and subsequent measures, concerning its attributes before entering to the adulthood in order for reassuring their developmental well-being in the future.

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

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