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Physics factor on human growth and development

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Abstract

Background: Growth and development are maintained primarily by genetic, hormonal, energy, environmental, and nutritional factors. Environmental factors become one of the important factors in influencing human growth and development. One of the environmental factors is the physical environment, which consists of climate/weather, sanitation, geographical conditions and others.

Purpose: Knowing the various components of physical environment factors that can affect human growth and development.

Methods: Literature review was conducted using secondary data from databases such as PubMed, Google Scholar, and ScienceDirect. The inclusion criteria focused on studies published between 2014-2024 that explored the phsyccs factor on human growth and development.

Result: 8 journals met the inclusion criteria and included in this review.

Conclusion: Growth is a change that is quantitative by increasing the number, size, organs, and individuals. One of the most influential factors on the rate of human growth and development is environmental factors. One of the environmental factors is the physical environment, which consists of climate/weather, sanitation, air pollution, geographical conditions, and others. In subtropical climates, spring has the highest growth rate and daylight exposure is also known to have a positive effect on human growth, then in sanitary conditions, clean sanitary conditions support the quality of nutrients which are important for human growth and development. In geographical conditions, the rate of human growth and development in highland populations tends to be slower. In addition, differences in human growth and development in different geographic states are also caused by complex factors ranging from economic differences in each geographic state, differences in resource distribution in each geographic state, etc. Meanwhile, air pollution has a role in inhibiting human growth in the fetal period, especially maternal smoking which affects the fetal genome

Keywords: Physic Factor; Growth and Development; Physical Environment; Air pollution

1. Introduction

Growth is a change that is quantitative by increasing the number, size, organs, and individuals. Humans are not only getting bigger physically, but also increasing the size and structure of the organs of the body and the brain. In addition, development is a process of increasing quantitative and qualitative characteristics. Development has the meaning of increasing ability and is the result of a maturity process [10].

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Growth and development are maintained primarily by genetic, hormonal, energy, environmental and nutritional factors. Environmental factors become one of the important factors in influencing human growth and development. One of the environmental factors is the physical environment, which consists of climate/weather, sanitation, geographical conditions, radiation and so on. Some of these components relate to one another in determining their influence on human growth and development [6].

The factors in the physical environment that are important to health include harmful substances, such as air pollution or proximity to toxic sites, access to various health-related resources, such as healthy or unhealthy foods, recreational resources, medical care and also community design and the "built environment" (e.g., land use mix, street connectivity, transportation systems) [11].

The environment can affect health through physical exposure, such as air pollution (OECD, 2012). A large body of work has documented the effects of exposure to particulate matter (solid particles and liquid droplets found in the air) on cardiovascular and respiratory mortality and morbidity. Research has identified specific physiological mechanisms by which these exposures affect inflammatory, autonomic, and vascular processes [2].

Agent, host, and environmental factors interrelate in a variety of complex ways to produce disease. Different diseases require different balances and interactions of these three components. Development of appropriate, practical, and effective public health measures to control or prevent disease usually requires assessment of all three components and their interactions. Agent originally referred to an infectious microorganism or pathogen: a virus, bacterium, parasite, or other microbe. While the epidemiologic triad serves as a useful model for many diseases, it has proven inadequate for cardiovascular disease, cancer, and other diseases that appear to have multiple contributing causes without a single necessary one. Host refers to the human who can get the disease. Environment refers to extrinsic factors that affect the agent and the opportunity for exposure. Environmental factors include physical factors such as geology and climate, biologic factors such as insects that transmit the agent, and socioeconomic factors such as crowding, sanitation, and the availability of health services. [3,13]

2. Material and methods

This article review was conducted by searching for information and data from international journal sources with criteria published in the last 10 years or after 2014. Searching for data sources used journals uploaded via Pubmed, Google Scholar, and ScienceDirect. The journal used contains the subject matter of "Physic Factor on Growth and Development" with physic factor on growth and development, sanitation on growth and development, geographic states on growth and development, weather and season on growth and development, air pollution on growth and development as the keywords. From several journals collected, a summary of the journal is made in the form of a table which includes the name of the researcher, year of publication of the journal, journal title, objective, research method, and research results.

3. Results and discussion

3.1. Result of Article Review

Table 1 Journal Summary Used for Article Review

No.	Author	Title	Objective	Method	Result
1.	Ngure, *et. al* (2014)	Water, Sanitation, and Hygiene (WASH), environmental enteropathy, nutrition, and early child development: making the links	This paper represents the argument that poor hygiene, resulting in microbial ingestion, is a risk factor for poor ECD. The writers review evidence on the links between clean water,	This paper uses the method of literature review which aims to collect and summarize findings from research that has been done before. The data source is in the form of national journal articles from the	Many risk factors for developmental deficits have been elucidated, and the potential role of hygiene must be considered in this context. This paper identified inadequate cognitive stimulation, stunting, iodine deficiency, and iron-deficiency anemia as key risks that prevent children from achieving their developmental potential. Other risk factors

			sanitation, and hygiene (WASH), and stunting and anemia, which are known risk factors for child developmental deficits, and highlight how current WASH interventions fail to adequately protect children in the first 3 years of life. The writers advocate for a more holistic view of WASH oriented to babies in the first years of life and for the development of interventions targeted to this age group.	year of 1955 to 2012. Selected journals discuss the making links of Water, Sanitation, and Hygiene (WASH), environmental enteropathy, nutrition, and early child development.	include intrauterine growth restriction (IUGR), malaria, lead exposure, human immunodeficiency virus (HIV) infection, institutionalization, and exposure to societal violence. There is emerging evidence of risks from prenatal maternal malnutrition, maternal stress, and families affected by HIV. Evidence of adverse effects of environmental toxins on child development has been well documented, with greatest attention toward lead, mercury, and polychlorinated biphenyls (PCBs), and more limited data on other heavy metals, solvents, and pesticides.
2.	Balasundaram and Avulakunta (2022)	Human Growth and Development	This paper aims to describe the stages of growth and development, to review the factors affecting growth and development, to outline the methods for growth measurements and standard screening tools for developmental assessment, and to explain how interprofessional collaboration and communication can improve patient outcomes when assessing a patient's physical development.	This paper uses the method of literature review which aims to collect and summarize findings from research that has been done before. The data source is in the form of national journal articles from the year of 1992 to 2020. Selected journals discuss the Human Growth and Development.	Speaking mainly about the factors affecting growth and development, this paper shows there are 9 factors. Those are genetic factors, fetal health, after birth, socio economics factors, family characteristics, human-made environment, nutrition, genetic and environmental factors, and role of experience during early childhood.
3.	Wilsterman and Cheviron (2021)	Fetal growth, high altitude, and	In this review, it provides new insight into these	Here, the paper examines human gestational	Many maternal, placental, and fetal physiological traits are altered by exposure to high

		evolutionary adaptation: a new perspective	questions by summarizing the current state of the field using a perspective based on evolutionary theory. This perspective can be broadly applied to help identify physiological traits or processes that are likely contributors to fetal growth outcomes at altitude. This paper then identify key areas where new approaches or questions are needed to advance our understanding of hypoxia-dependent fetal growth restriction from an evolutionary vantage point	physiology at high altitude from a novel evolutionary perspective that focuses on patterns of physiological plasticity, allowing us to identify *1*) the contribution of specific physiological systems to fetal growth restriction and *2*) the mechanisms that confer protection in highland-adapted populations. Using this perspective, the paper highlights two general findings: first, that the beneficial value of plasticity in maternal physiology is often dependent on factors more proximate to the fetus; and second, that writer's ability to understand the contributions of these proximate factors is currently limited by thin data from altitude-adapted populations. Expanding the comparative scope of studies on gestational physiology at high altitude and integrating studies of both maternal and fetal physiology are needed to clarify the mechanisms by which physiological responses to altitude contribute	altitude in humans with lowland ancestry, but evidence for the contribution of any specific change in these traits to fetal growth outcomes remains limited. The simplest explanation for fetal growth restriction at altitude would be that lower oxygen directly limits growth of the fetus. However, plasticity in the placenta and/or fetal hematology appears sufficient to achieve necessary uptake and consumption of oxygen in lowlanders and highlanders alike. Altitude-dependent fetal growth restriction is therefore likely linked to indirect effects of low oxygen on gestational physiology that constrain fetal growth trajectories. Relevant factors may include vascular stress in and around the placenta and change in nutrient delivery to the fetus, but there are relatively few data quantifying these factors in situ, especially during early development.

				to fetal growth outcomes. The relevance of these questions to clinical, agricultural, and basic research combined with the breadth of the unknown highlight gestational physiology at high altitude as an exciting niche for continued work.	
4.	De Leonibus, *et. al.* (2016)	Effect of summer daylight exposure and genetic background on growth in growth hormone-deficient children	The aims of the present study were (A) to assess whether living at different latitudes with different numbers of summer daylight hours impacted on annual HV in children with GHD treated with r-hGH, (B) to investigate the possible interaction between summer daylight and growth-related genetic markers on HV12 and (C) to use the difference in gene expression profile associations to identify pathways and hence mechanisms associated with this interaction.	All auxological data were expressed as median and interquartile ranges [median (Q1,Q3)]. Uncorrected P-values o0.05 were considered statistically significant. Statistical analysis was performed using the Statistical Package for Social Science program, version 20.0 software for Windows (SPSS, Chicago, IL, USA). Differences in continuous variables were examined for unpaired samples by the Kruskal–Wallis test, whereas differences in categorical variables were assessed by Fisher's exact test. Correlations between variables were assessed by Pearson's correlation coefficient. Partial least squares regression (PLSR) was applied to	The response to growth hormone in humans is dependent on phenotypic, genetic and environmental factors. The present study in children with growth hormone deficiency (GHD) collected worldwide characterized gene-environment interactions on growth response to recombinant human growth hormone (r-hGH). Growth responses in children are linked to latitude, and the writers found that a correlate of latitude, summer daylight exposure (SDE), was a key environmental factor related to growth response to r-hGH. In turn growth response was determined by an interaction between both SDE and genes known to affect growth response to r-hGH. In addition, analysis of associated networks of gene expression implicated a role for circadian clock pathways and specifically the developmental transcription factor NANOG. This work provides the first observation of gene-environment interactions in children treated with r-hGH.

				overcome multicollinearity between variables.18 By using PLSR, the 'variable important for projection' coefficients were computed and a value of o0.8 was considered to be small and not contributing significantly to the prediction model.19 To examine which variables had a major impact on the prediction of HV, independent variables were used, including latitude and summer daylight, GH peak, r-hGH dose, BW SDS, baseline BMI SDS, distance to TH SDS, age and gender; HV was used as the dependent variable.	
5.	Malina, *et. al* (2018)	Geographic variation in the growth status of indigenous school children and youth in Mexico	To analyze variation in the growth status of indigenous children and youth attending bilingual schools, escuelas albergues, for the indigenous population in México	The children and youth attended escuelas albergues in 1,009 localities in 21 Mexican states in 2012. Heights and weights of 31,448 boys and 27,306 girls 6–18 years of age were measured by trained staff at each school; the BMI was calculated. The students were divided into five geographic regions for analysis: North, Central, South-Gulf, South-Pacific,	The geographic gradient in heights of indigenous children and youth was consistent with a north-to-south pattern noted among indigenous adults in studies spanning 1898 through 2013. Variation in height among children and youth likely reflected ethnic-specific and geographic variation interacting with economic and nutritional factors

				and South-Southeast. Growth status was compared to United States reference percentiles (P).	
6.	Momberg, *et. al.* (2020)	Water, Sanitation, and Hygiene (WASH) factors associated with growth between birth and 1 year of age in children in Soweto, South Africa: result from the Sowety Baby WASH study	This study aims to provide evidence linking WASH and nutritional status in infants, to brigs evidence regarding the associations between WASH and nutritional status in children in South Africa, to highlight the importance of access to sanitation at household as well as community levels, and to begin the process of developing indices related to WASH and nutritional status in children in South Africa	This study drew cross-sectional data from a longitudinal cohort study and used hierarchical regression analyses to assess associations between WASH factors: water index, sanitation, hygiene index, and growth: height-forage (HAZ), weight-for-age (WAZ), weight-for-height (WHZ) at 1, 6, and 12 months postpartum among infants a priori born healthy in Soweto, Johannesburg. Household access to sanitation facilities that were not safely managed was associated with a decrease in HAZ scores at 1 month (β ¼ 2.24) and 6 months (β ¼ 0.96); a decrease in WAZ at 1 month (β ¼ 1.21), 6 months (β ¼ 1.57), and 12 months (β ¼ 1.92); and finally, with WHZ scores at 12 months (β ¼ 1.94). Counterintuitively, poorer scores on the hygiene index were associated with an increase at 1 month for both HAZ (β ¼ 0.53)	The evidence suggests that the biggest impact relating to water is likely to affect WAZ around 12 months while the Table 6 greatest impact of hygiene is around 1 month postpartum and is likely to affect HAZ and WAZ. Access to safely managed sanitation facilities is critical throughout the first year and impacts HAZ, WAZ, and WHZ. Interventions intending to address issues surrounding WASH in early childhood and nutritional status would therefore benefit from taking this timing into account and recognising specific timepoints in early childhood, and associated WASH factors for intervention. WASH is an important factor influencing infant growth, and improvements to both household and community level sanitation may be required in order to achieve targets in terms of minimising undernutrition

				and WAZ (β ¼ 0.44). Provision of safely managed sanitation at household and community levels may be required before improvements in growth-related outcomes are obtained	
7.	Buris and Baccarelli (2017)	Air pollution and in utero programming of poor fetal growth	This paper aims to find out how air pollution affects on poor fetal growth reviewed from the in utero programming scope.	This paper uses the method of literature review which aims to collect and summarize findings from research that has been done before. The data source is in the form of national journal articles from the year of 1990 to 2016. Selected journals will discuss the effect of air pollution on poor fetal growth reviewed from the in utero programming scope.	Maternal cigarette smoking in pregnancy represents one of the most preventable causes of poor fetal growth. Air pollution, which contains many of the same compounds found in cigarette smoke including fine particulate matter smaller than five microns in diameter (PM2.5), has been shown to increase the risk of many of the same conditions caused by smoking including lung cancer and cardiovascular disease. Further, air pollution exposure in pregnancy is associated with lower birth weight for gestational age. How air pollution affects fetal growth is incompletely understood, but new insights into how the fetal epigenome responds to cigarette smoke may provide clues as to how air pollution may affect the developing fetus.
8.	Goldizen, Sly, and Knibbs (2016).	Respiratory effects of air pollution on children	This paper aims to discuss air toxicants impact on children's respiratory health, routes of exposure with an emphasis on unique pathways relevant to young children, methods of exposure assessment and their limitations and the adverse health	This State of the Art examines published data on the effects of indoor and ambient air pollution on the prenatal and childhood respiratory system, determines the current gaps in our knowledge and presents a way forward for future research. We provide an	While there are considerable data linking early life exposure to air pollution to both short- and long-term adverse health effects, important knowledge gaps still exist. A substantial component of the global burden of disease is attributable either directly or indirectly to air pollution exposure. Ambient air quality can be improved through regulation and technology to reduce vehicle and industrial emissions. Indoor air pollution, especially from biomass and solid fuel burning, should be considered

			consequences of exposures.	overview of air toxicants commonly present in air pollution, indoor and outdoor sources of air pollution and the pathways of exposure. However, it is outside the scope of this article to review the respiratory effects of environmental tobacco smoke exposure in children as they have been reviewed extensively elsewhere.	social justice and human rights issues to which solutions exist but are not widely applied. A greater understanding of the adverse health consequences of exposure to air pollution in early life is required to encourage policy makers to reduce such exposures and improve human health

3.1.1. Weather and Season

According to the study conducted by Balasundaram and Avulakunta in 2022 [1], in a year there is a period where growth and development becomes three times faster than a normal growth and development speed. This period is synchronized with the weather and the fastest development speed occurs in autumn. In other tropical season continents, such as Indonesia, the sunny season is faster than the rainy season. This condition occurs because there is an assumption that availability of food is lower during the rainy season so that it becomes a factor slowing down human growth and development during the rainy season in tropical countries.

On a research conducted by Balasundaram and Avulakunta [1] as well, in Peru, it shows that high body gesture doesn't always defined as reproductive advantage. In industrial countries, woman that has a high posture will likely has a successful reproduction than a smaller woman. Nevertheless, in a rough environment on Peruvian Andes, smaller women have more potency to create a surviving offspring.

A study conducted by Leonibus *et. al.* [5] also said that growth and development rate is different between a sunny season and dark season. Leonibus *et. al.* [5] also said that daylight exposure affects the growth and development rate on becoming faster, but they do not say that this is because of the availability of food. Their study focuses on the hormonal changes causes by the daylight exposures that later fasten the growth and development rate. Differences in melatonin secretion due to variation in day length were proposed to explain the variation in height inhibiting sexual and skeletal maturation. The link between day length and melatonin secretion resides in the eye, a light-sensitive organ whose function is to maintain circadian and seasonal rhythms, as facilitated by retinal communication via neural tracts with the pineal gland. A circadian clock has been found to be primarily mediated by melanopsin-containing retinal ganglion cells, which are intrinsically blue-light sensitive. A number of studies have also provided support for a link between seasonal changes in daylight and physiological alterations, including human growth, with the existence of a seasonal variability in growth patterns in normal children. Growth appears to speed up during times of greatest daylight exposure and slow down during periods of darkness

3.1.2. Sanitation

According to the study done by Ngure *et. al.* [14], sanitation is linked with the condition of nutrition in some countries and it's effect on human growth and development. Adequate and healthy sanitized nutrition during pregnancy and the first 2 years of life is necessary for normal brain development, which lays the foundation for future cognitive and social ability, school success, and productivity. Undernutrition affects brain development directly, and also affects physical growth, motor development, and physical activity, which may, in turn, influence brain development through both caregiver behavior and child interaction with the environment Ngure *et. al.* [14], carried out that awful sanitation condition is responsible on 50% of maternal and underweight children. A bad sanitation condition obviously won't

produce good human growth and development, because in the process of growing, humans needs a good nutrition quality, and if its not sufficient, the growing and developing process won't be optimal.

Meanwhile, a study in South Africa conducted by Momberg *et. al.* [9] found that in the current South African context, there was no association between water conditions and growth outcomes in the various models. Noteworthy, however, is the negative association between the water index and WAZ (weight-for-age) at 12 months after adjusting for infant characteristics at birth, but not after adjusting for maternal or household characteristics, which may mean that the effect might be relative to nutritional status at birth. However, this article seems to agree that water, sanitation, and hygiene (WASH) take a huge responsibility of the quality of nutrition. Momberg *et. al.* [9] stated that WASH is an important factor influencing infant growth, and improvements to both household and community level sanitation may be required in order to achieve targets in terms of minimizing undernutrition.

3.1.3. Air Pollution

Buris and Baccarelli [3] viewed air pollution effect on human growth and development from the scope of human's fetal period. The main adverse effect of air pollution on human growth and development is because of the smoke and the smoking behavior from the maternal. The smoke pollution has many micro dangerous substance that has proven that it can cause lung cancer and cardiovascular diseases. Further, air pollution exposure in pregnancy is associated with lower birth weight for gestational age. Unfortunately, How air pollution affects fetal growth is incompletely understood, but new insights into how the fetal epigenome responds to cigarette smoke may provide clues as to how air pollution may affect the developing fetus.

On the same side, a study conducted by Goldizen *et. al.* [7] assumpted that air pollution through maternal can affect human growth and development during the prenatal period. Maternal air pollution, environmental tobacco smoke, and BMF exposure have been positively associated with intrauterine growth restriction, low birth weight, and premature birth. In addition, Exposure to ambient air pollution and indoor biomass fuel combustion during childhood may reduce somatic and skeletal growth. a study reported that Polish children has a height deficit of 1.5 cm in exposed preadolescent children, when compared to less exposed children residing in the same city. Ambient air pollution accounted for 3.1% of the total growth rate variability. It is biologically plausible that air pollution negatively effects childhood growth through the genotoxicity of chemical air pollutants, the effect of low birth weight or IUGR on later development, or the negative effects of lung function deficits and frequent respiratory infections. The small number of studies, inadequate controlling for socio-economic factors in some studies, and selection bias in some studies prevents an association from being confirmed.

3.1.4. Geographical States

Wilsterman and Cheviro [15] stated that geographic states where human lives takes a responsibility on human growth and development as well. They stated that population who lives in high altitude, such as mountains, tend to have a shorter posture than those population who live at low altitude places. This condition occurs because the oxygen saturation on high altitude places is lower than that of the low altitude places. Hypobaric hypoxia said to be the cause of restriction of fetal's growth. For the reference, hypobaric hypoxia is the state in which the partial pressure of oxygen is reduced [10]. There are indirect and direct effects between the minimum availability of oxygen and fetal growth. The direct effect is the hardness of the fetus to gain adequate oxygen to grow, whether the indirect effect leads to the response of the maternal, placenta, and fetal physiology to hypoxia that can slow down the fetal growth.

On the other side, Malina *et. al.* [8] viewed geographical states on affecting human growth and development from different scope. They see it on the state's economical condition. Their research in Mexico found out that indigenous children at North Mexico has the tallest posture, while the shortest posture belongs to South-Pacific and South-Southeast regions. The preceding likely reflected the economic, health, and nutritional conditions in the different regions of Mexico. Both the North and Central regions, for example, have reasonably well-established economies given their proximity to the US border. The status of children and youth in the South-Gulf region was generally intermediate between those in the North and Central and the South-Pacific and SouthSoutheast states, and was more variable, which may have reflected the uneven distribution of resources in Puebla and Veracruz. The apparently "affluent" state of Puebla, for example, had a high estimated rate of poverty. In contrast, body weights and BMIs of children and youth in the five regions overlapped during childhood but showed more variation during adolescence

4. Conclusion

Growth (growth) is a change that is quantitative by increasing the number, size, organs, and individuals. One of the most influential factors on the rate of human growth and development is environmental factors. One of the environmental

factors is the physical environment, which consists of climate/weather, sanitation, air pollution, geographical conditions, and others. In subtropical climates, spring has the highest growth rate and daylight exposure is also known to have a positive effect on human growth, then in sanitary conditions, clean sanitary conditions support the quality of nutrients which are important for human growth and development. In geographical conditions, the rate of human growth and development in highland populations tends to be slower. In addition, differences in human growth and development in different geographic states are also caused by complex factors ranging from economic differences in each geographic state, differences in resource distribution in each geographic state, etc. Meanwhile, air pollution has a role in inhibiting human growth in the fetal period, especially maternal smoking which affects the fetal genome. This study hopes to benefit the reader to be aware of physical environmental factors on human growth and development.

Compliance with ethical standards

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Disclosure of conflict of interest

All the authors of declare that there is no any conflict of interest with this document's release

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