
Health care of hypothyroidism during pregnancy and next postnatal neurocognitive functions: A Systematized Literature Review

Atención médica del hipotiroidismo durante el embarazo y funciones neurocognitivas posteriores al parto: Una revisión de Literatura Sistematizada

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Abstract

Hypothyroidism is a metabolic disorder in which the tetraiodothyronine hormone (TS4) is insufficiently produced. In newborns, the lack of TS4 hormone impacts the central nervous system and could contribute to a low intelligence quotient and intellectual disabilities. In Puerto Rico, hypothyroidism is more prevalent among women, representing a 24.2% of the population. However, there is lack of literature on the impact of hypothyroidism during pregnancy and neurocognitive outcomes on their children in Hispanics population. Our purpose is to perform a systematized literature review (SLR) to 1) describe the current knowledge in health care of hypothyroidism during pregnancy and 2) know the subsequent neurocognitive functions on their children, to promote research in the Hispanic population. A five phase protocol was used, to identify 106 articles from peer-reviewed databases from August to October 2019. Thirty articles were identified as duplicated and 40 met the inclusion criteria for the analysis. Articles were analyzed using descriptive statistics such as measures of central tendency. This SLR described the current knowledge on maternal hypothyroidism and adverse neurocognitive and neurodevelopmental outcomes in offspring. An 80% of the articles reported that hypothyroidism affects the cognition on children born from mothers with hypothyroidism during pregnancy. However, we do not have this kind of data in Hispanic population that allow us to implement health care and psychoeducational programs for pregnant women with hypothyroidism.

Keywords: Hypothyroidism, neurocognition, health psychology

Resumen

El hipotiroidismo es un trastorno metabólico en que la hormona tetrayodotironina (TS4) se produce de forma insuficiente. En los recién nacidos, falta de la hormona TS4 impacta el sistema nervioso central y podría contribuir un cociente intelectual bajo y discapacidades intelectuales. En Puerto Rico, el hipotiroidismo es más prevalente entre las mujeres, representando un 24.2% de la población. Sin embargo, hay poca literatura sobre el impacto del hipotiroidismo durante el embarazo y los resultados neurocognitivos en sus hijos en la población Hispana. Nuestro propósito es realizar una revisión sistematizada de la literatura (SLR) para: 1) describir el conocimiento actual del cuidado de salud en el hipotiroidismo durante el embarazo, 2) conocer las funciones neurocognitivas subsecuentes en sus hijos, para promover la investigación en población hispana. Un protocolo de cinco fases fue utilizado, para identificar 106 artículos preliminares en bases de datos revisadas por pares desde Agosto a Octubre del 2019. Treinta artículos fueron identificados como duplicados y 40 cumplieron los criterios de inclusión para el análisis. Los artículos fueron analizados utilizando análisis descriptivo de medidas de tendencia central. Esta SLR describe conocimiento actual del hipotiroidismo materno, resultados adversos neurocognitivos y del neurodesarrollo en sus hijos. El 80% de los artículos reportaron que el hipotiroidismo afecta la cognición en niños nacidos de madres con hipotiroidismo durante el embarazo. Sin embargo, no contamos con este tipo de datos en la población Hispana que nos permitan implementar programas del cuidado de salud y psicoeducativos para mujeres embarazadas con hipotiroidismo.

Palabras Claves: Hipotiroidismo, neuro cognición, psicología de la salud

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Introduction

Hypothyroidism is a metabolic disorder in which the tetraiodothyronine hormone (TS4) by the thyroid gland is insufficiently produced (Khan, 2017). Khan et al., (2017) also states that this hormone regulates metabolism, growth, and reproduction. It also prevents the release of the thyroid hormone, allowing the body to maintain a constant level of thyroid hormones. Patients with insufficient production of TS4 usually manifest a series of symptoms such as low metabolic rate, tendency to weight gain, fatigue and lethargy, sensitivity to cold, and menstrual disturbances (Alexander et al., 2017).

Thyroid disease is the second most common endocrine disorder, after diabetes mellitus, affecting women of reproductive age (Abalovich et al., 2007; Casey et al., 2006.; Casey et al., 2007). A 15.5% of women in the U.S. have hypothyroidism during their pregnancy. Of these cases, 30% to 80% are undetectable or missed during pregnancy (Mintziori et al., 2015). Untreated hypothyroidism and an elevated TS4 concentration have been associated with adverse pregnancy complications such as increased risk of miscarriage, hypertension, preeclampsia, preterm delivery, gestational diabetes mellitus (GDM) and placental abruption (Hosseini et al., 2017). In a worldwide study conducted by Ford (2014), 71% of infants are not born in countries with a newborn screening program and much of the offspring from mothers with hypothyroidism during pregnancy are not detected.

In Puerto Rico, a 35.1%, of the population suffers from hypothyroidism (*Departamento de Salud de Puerto Rico, [DSPR], 2016*). Studies in Puerto Rico establish that hypothyroidism is more prevalent among women, representing a 24.2% of the total population (González, 2013). Psychological

studies about hypothyroidism has been studied from the comorbid depressive and anxiety symptomology associated with TS4 hormone dysregulation in adults (Siegman et al., 2018). However, thyroid hormone deficiencies during pregnancy are also a critical event that could potentially interact with the development of the fetus (Bernal, 2015). In Puerto Rico, a 98% of newborns are screened for thyroid conditions. Nonetheless, a clear number of cases due to hypothyroidism in pregnancy has not been well documented (Ford et al., 2014). Consequentially, an estimate of women with hypothyroidism during pregnancy in Puerto Rico might be unreliable. Furthermore, there is little to no research of the impact of hypothyroidism in pregnancy in Hispanic population such as Puerto Rico, and therefore the neurocognitive functions in their offspring.

Treatment for hypothyroidism in pregnancy

The most common type of hypothyroidism in pregnancy are subclinical hypothyroidism (SCH) and maternal hypothyroxinemia (i.e., low/suboptimal TS4) (Fan et al., 2019). Subclinical hypothyroidism is defined as serum thyroid-stimulating hormone (TSH) >97.5% and normal free thyroxine (FT 4), with or without thyroid antibodies (Bernardi et al., 2013). Maternal hypothyroxinemia is known to reduce fetal supply of the hormones, since the direct transfer of maternal TS4 over the placenta is extremely low (Abel et al., 2018). Most women with hypothyroidism need a 30% to 50% increase in the dose of levothyroxine (a TS4 hormone regulator) during pregnancy and this increased dose requirement occurs as early as the first 4 to 6 weeks of gestation (Chakera et al., 2012). In a study conducted by Akram et al. (2017), half of the women with known hypothyroidism, were treated with an inappropriately low dose of TS4, indicating

that a high number of women are not receiving the treatment they need. Another treatment method for hypothyroidism during pregnancy is iodine intake. Connelly et al. (2012) indicates that there is a debate on the beneficial outcomes of iodine intake in pregnancy. While some suggest that the excess of iodine levels in women can cause a transient decrease in thyroid hormone production, other suggests the necessity of iodine intake for hippocampus development in the fetus (Andersen et al., 2017). The fetal thyroid gland begins to incorporate iodine late in the first trimester of pregnancy, but the fetus does not start to secrete its own thyroid hormones until the 18th to 20th week of pregnancy. Therefore, the fetus is dependent on the circulation of maternal thyroid hormone levels (Akram et al. 2017).

Thyroid hormones in neurodevelopment

Bernal (2015) explains how thyroid hormones are essential for neurodevelopment through specific time windows influencing neurogenesis, neuronal migration, neuronal and glial cell differentiation, myelination, and synaptogenesis. It also promotes growth via its effect on protein synthesis, which plays a key role in differentiation, development, and tissue maturation, making thyroid hormone essential for brain cell proliferation. Furthermore, thyroid hormones play critical roles in several organs especially the neurological, cardiovascular, and skeletal system (Min, 2016). In newborns, the central nervous system function may be impaired due to lack of the TS4 hormone which contributes to a low intelligence quotient (IQ) and intellectual disabilities (Thompson et al., 2017).

Abnormalities in the development of hippocampus and impaired memory have also been found in rats and in human offspring exposed to maternal

hypothyroidism (Andersen et al., 2018). Studies have supported the hypothesis that the human fetal brain can respond to maternal TS4 from as early as 7 weeks, which could influence human central nervous system development (Harder, 2018). This evidence suggests the importance of TS4 transporters in the regulation of both the entry of TS4 into brain and the passage of TS4 across the plasma membranes of neuronal cells (Anderson, 2008). To ensure normal neurodevelopment in the younger generation, adequate thyroid hormone is vital for women during pregnancy and lactation (Min et al., 2016).

Congenital conditions in offspring

Children from mothers with hypothyroidism during pregnancy have presented other congenital conditions such as Autism Spectrum Disorder (ASD) and Attention-Deficit and Hyperactivity Disorder (ADHD) (Gül, 2018). Findings in a cohort study by Roman GC, et al (2013), showed that there is a consistent association between maternal TS4 levels, due to hypothyroxinemia, and children's autistic symptoms. Also, ADHD has been postulated to be related to the function of thyroid hormones since slightly increased thyroid-stimulating hormone (TSH) levels have been reported in several ADHD studies (Langrock et al., 2018). Oostenbroek et. al (2017), found that teacher reported hyperactivity /inattention in children, from 5 to 6 years old, could be associated with lower levels of maternal TS4 during the first trimester of pregnancy, but there was no association with the parental reports on the same behavior. Despite the incongruence, their study can support previous findings that suggest the ADHD symptoms in children age 5 to 6 years old, could be due to problems with thyroid hormone supply by the mother (Ghassabian et al., 2010).

Neurocognitive functions in offspring

Hypothyroidism in general has been associated with several cognitive deficits including psychomotor speed, visual-spatial skills, and memory (Khorasani et al., 2019). Patients with untreated hypothyroidism exhibit a specific memory retrieval deficit for verbally presented material (Miller, 2007). However, there is still a current debate on cognitive deficits on offspring from hypothyroidism during pregnancy. Studies debate the association between low maternal TS4 and child verbal comprehension, Intelligence Quotient (IQ), Attention Deficit - Hyperactivity Disorder (ADHD), psychomotor deficiencies and language (Andersen, et al., 2018). In a longitudinal study by Perez-Lobarto et al., (2015), evaluated children nine to fifteen years of age from the U.S., of mothers diagnosed with hypothyroidism during pregnancy. These results were found to recall fewer episodic details than control children in the context of an autobiographical memory interview, suggesting a memory impairment related to the hippocampus. Additionally, IQ, verbal expression/comprehension, attention, and verbal fluency abilities were positively and significantly associated with the third percentile of TS4 in this study.

Other studies in the United States have found reduced scores on tests of intelligence, attention, and visual-motor performance at 8 years of age among children of 48 mothers with untreated clinical hypothyroidism (Chevrier, 2011). Offspring of women with a previous diagnosis of thyroid dysfunction, who were not treated in early pregnancy, also had lower neurocognitive performances when compared with children born to women without thyroid disease (Milanesi et al., 2011). Pääkilä et al., (2015) study also associated maternal hypothyroidism with

poorer psychomotor development in children, a delay in expressive language, nonverbal cognition, and autism. This study also revealed that female offspring from mothers with subclinical hypothyroidism had more self-evaluated difficulties in mathematics than female offspring of control mothers. While masculine offspring of hypothyroid mothers had a lower academic performance than masculine offspring of control mothers.

Purpose of the present study

There is little to no investigation of neurocognitive processes among Hispanic population. Studies in the Psychoneuroendocrinology specially are mostly conducted in Europe and the United States. Most of the studies in the United States have been conducted in non-Hispanic population (Caucasians and African American). Only a few studies have reported the prevalence of thyroid dysfunction in the Hispanic population, regarding congestive heart failure and congenital hypothyroidism (Marzouka et al., 2011; Hinton et al., 2010). However, literature on the impact in the offspring due to hypothyroidism in pregnancy has not been completely studied in this population. Therefore, developing literature to identify if there is an impact of neurocognitive functions in offspring from mothers with hypothyroidism during pregnancy is needed to determine the importance of researching this topic in Hispanic. This study will promote the implementation of health care and psychoeducational programs for pregnant women with hypothyroidism.

Consequently, our general purpose is to perform a SLR to 1) describe the current knowledge in health care of hypothyroidism in pregnancy and 2) know the subsequent neurocognitive functions on their children. Our objectives are 1) to identify treatment of

hypothyroidism during pregnancy, 2) explore if there is an impact of hypothyroidism during pregnancy; 3) to describe congenital conditions of offspring from women with hypothyroidism during pregnancy, and 4) to identify what are the subsequent effects on neurocognitive functions on the offspring of mothers with hypothyroidism during pregnancy. The explicit statement questions are: 1) What treatments in hypothyroidism in pregnancy are used? 2) How is the healthcare and impact of hypothyroidism during pregnancy? and 3) What are the subsequential neurocognitive functions seen in newborns from mothers with hypothyroidism during pregnancy? Answering these questions will provide awareness of healthcare in this condition and the impact on neurocognitive functions in their children. As well, it will provide the opportunity to develop psychoeducational programs for pregnant women with hypothyroidism.

Method

The researchers conducted a SLR using peer-reviewed databases from August to October 2019. A systematized protocol was developed using a five-phase method; however, these did not meet the PRISMA criteria since it did not evaluate risk of bias, as seen in [Figure 1](#).

Inclusion criteria

The following inclusion criteria were used: a) identifies hypothyroidism in pregnancy, b) provides data on neurocognitive function regarding hypothyroidism in pregnancy and their offspring, (c) articles must have been published in peer-reviewed journals from 2005-2019.

Exclusion criteria

The exclusion criteria were a) studies without treatment during pregnancy, b) studies that did not report congenital conditions from the offspring and c) studies that did not evaluate neurocognitive functions.

Identification of studies

The databases selected for the SLR were Google Scholar, Research Gate, PubMed, Psych Info, PsycArticles, Psychology and Behavioral Sciences Collection, Statistics, Access OBGYN, Access Pediatrics, Cochrane Databases for systematic reviews and Open Access Journals. These were assigned randomly between researchers. Most of the articles were found through *Google Scholar* with twenty-two articles and *Open Access Journals* with twelve articles. However, other databases were used such as: PubMed with three articles, and Psych Info with three articles. Keywords used for navigating the databases were: neurocognitive functions, pregnancy, and hypothyroidism. Both Spanish and English articles were found in these databases. The electronic strategy used was selecting peer-reviewed articles from 2005 to 2019 that meets the inclusion criteria in each database, using the keywords mentioned above. After, the investigators documented the number of articles found in each database that met the inclusion and exclusion criteria in the title and abstract, to later evaluate in the data extraction.

Extraction of data

In the pre-phase, as seen in [Table 1](#), a protocol development was developed to select the databases and the procedure for the SLR. For the first phase, an initial search was conducted using the keywords in all the databases mentioned above, where 86 articles

were found. In the second phase twenty articles were identified. However, the databases of *Statistics, Psychology and Behavioral Sciences Collection, Statistics, Access OBGYN, Access Pediatrics* did not reveal literature on this topic, and therefore were eliminated. Finally, in phase three, 106 articles were identified between one and two phases with the following criteria: a) the title meets the inclusion criteria and b) the abstract meets with the inclusion criteria. From these, 30 articles were duplicated, and 70 articles were selected for phase four. In phase four, 30 articles met the exclusion criteria, therefore a total of 40 articles met with the inclusion criteria. In phase four, the data extraction was conducted using the following variables: participants, neurocognitive functions, treatment in pregnancy, newborn screening (NBS), complications during pregnancy and labor (prematurity, abortions, or miscarriages), medical follow ups and impact of hypothyroidism during pregnancy in neurocognitive functions in their offspring. These variables were selected by recommendations based on recent literature reviews on this topic prior to this study (Morthada et al., 2018). Finally, in phase five the data extraction was then uploaded into an SPSS 23 program, where all the variables are coded to identify the frequency that they appeared through the articles and descriptive analysis using measures of central tendency were done.

Characteristics of the article samples

In this SLR, all studies that met with the inclusion criteria evaluated hypothyroidism in pregnancy as seen [in Table 2](#). The most studied population were pregnant patients and their offspring (PPHO) (50%). A 30% of the articles were, patients who were not pregnant, but did have hypothyroidism (PH); they were used to be compared to women with hypothyroidism. Third, it was followed by a

10% of pregnant patients (PP) without the condition, who were used as control groups for pregnant patients with hypothyroidism. Finally, 5% of children with hypothyroidism (CBPPH) and animals were the least number of samples mentioned in the articles.

Results

The 40 articles that met the inclusion criteria were published between 2005 and 2019. These articles were published in eleven different databases. The purpose of this study is to describe the current knowledge in health care of hypothyroidism in pregnancy and the subsequent neurocognitive functions on their children. The objectives of this SLR are: 1) to identify treatment of hypothyroidism during pregnancy, 2) explore if there is an impact of hypothyroidism during pregnancy; 3) to describe congenital conditions of offspring from mothers with hypothyroidism during pregnancy, and 4) to identify what are the subsequent effects on neurocognitive functions on the offspring of mothers with hypothyroidism during pregnancy.

Treatment and outcomes

To evaluate the first objective, treatments prescribed in women with hypothyroidism reported in the articles were identified. The use of TS4 and TS3 screening was the preventative treatment technique with the highest frequency compared to other treatments. Forty percent of the articles reported the use of screening techniques to detect the TS4 and TS3 hormone level throughout the pregnancy. However, in most studies, 60%, the use of iodine supplements, which are essential for the diet of women with hypothyroidism during pregnancy, was absent. Furthermore, 55% of studies did not report recommendations to follow up for the mother and offspring.

Impact of hypothyroidism during pregnancy

To explore the second objective, the impact of hypothyroidism during pregnancy included prematurity, natural abortions, and neurocognitive impact on offspring was described. The 65% of studies found that prematurity was not a common occurrence. Also, 75% of studies identified that natural abortions were not common. However, 80% of studies indicated that the neurocognitive and neurodevelopment functions in offspring of women with hypothyroidism were altered.

Congenital conditions of the offspring

To respond to the third objective of this review, the congenital conditions of offspring of mothers with hypothyroidism were identified using descriptive analysis, as presented in [Table 3](#). Twenty-five studies reported an association between a lack of hormones in the first trimester with certain congenital conditions in the offspring of women with hypothyroidism during pregnancy. Thirty-seven percentage of the articles reported that Autism Spectrum Disorder (ASD) was the most common congenital condition in offspring of mothers with hypothyroidism during pregnancy, followed by ADHD with a 27% reported. While intellectual disfunction and increased mobility were both reported by a 18%.

Neurocognitive functions

In terms of neurocognitive functions, 50% of the articles reported that offspring presented deficiencies in both fine and gross motor functions. A 40% of the articles established that the offspring from mothers with hypothyroidism exhibited a low IQ compared to those whose mothers did not have the condition during pregnancy. Both, verbal comprehension, and language deficits,

were reported in 15% of the articles, followed by memory and processing speed reported in 10% of the articles. Finally, 5% of the articles presented deficiencies of communication, attention, and psychomotor functions in the offspring of mothers with hypothyroidism during pregnancy. In [Table 4](#), a summary of the neurocognitive functions found are detailed.

Discussion

The purpose of this study is to perform a systematized literature review (SLR) to 1) describe the current knowledge in health care of hypothyroidism during pregnancy and 2) know the subsequent neurocognitive functions on their children, to promote research in the Hispanic population. As a response to the general purpose the results show that 80% of the articles reported that hypothyroidism affects the cognition on children born from mothers with hypothyroidism during pregnancy. These results lead the investigators to question how the health care of women with hypothyroidism is carried out worldwide and if it is similar to the Hispanic population. Hypothyroidism is a public health concern for Puerto Rico since 35.1% of the population suffers from the condition compared to 23% of Hispanics in the United States (Marzouka et al., 2011). Therefore, this could imply the necessity of research in Hispanic population to see if it has the same or higher impact as the countries mentioned. Also, most studies in this SLR have focused only on the effect of IQ. Therefore, the aim of future studies should be based on contemporary intelligence theories on the interaction of neurocognitive processes involved in all behavior and not depart from classical definitions that considered intelligence as the sum of acquired skills in future studies (Moreno et al., 2018).

In terms of the second objective most of the articles reported the use of a TS4 and TS3 screening technique in pregnancy to confirm the condition. This screening technique is widely recommended in most studies, as a preventive strategy. Like most meta-analysis, our results showed that women reported to use synthetic levothyroxine as an adequate replacement of thyroid hormone, since their daily requirements may increase by 25% to 100% (Chakera et al., 2012). Iodine intake and follow up appointments were less frequent in our SLR compared to other studies (Connelly, 2012). Furthermore, in contrast to numerous studies, abortions and prematurity were not frequent in the articles reviewed (Alemu et al., 2016; Li et al., 2018; Hosseini et al., 2017).

For the third objective in assessing congenital conditions, a 37% of the studies reported the possibility of the children developing ASD when their mother's had hypothyroidism in early pregnancy. This finding was similar to other studies that presented the link between both conditions (Roman et al., 2013). Furthermore, early uncontrolled treatment studies suggested that children with ASD showed a positive clinical response to TS4 (Frye et al., 2017). Therefore, initial treatment is essential for pregnant women with hypothyroidism. ADHD was the next highest congenital condition found in our review, with 27% of articles reporting this. Concerningly, ADHD has increased from 3.8% to 6.4% from 2014 to 2016 and two out of three children (63.8 %) had at least one co-occurring condition (Xu, 2018). As well, Weis, et al (1993) has suggested that the prevalence of thyroid abnormalities is higher (5.4%) in children with ADHD than in the normal population (<1%). These findings suggest that there should be a broader focus of the impact thyroid hormones have in the association of cognitive conditions such as Autism and

ADHD. An 18% of the studies reported an Intellectual Disfunction and Increased mobility, this was comparable to the studies of Päckilä (2015).

Finally, to address the fourth objective the subsequent effects on neurocognitive functions in offspring from mothers with hypothyroidism were identified. The most common deficiencies in offspring from women with hypothyroidism while in pregnancy were motor functions (gross and fine motor functions), rather than a low intelligence quotient, which were thought to be the most common effect. Most articles in this review studied motor function since it is a crucial role on neurodevelopment. For example, in a study conducted by Costeira (2011), motor performance was found at a mild functioning level due to hypothyroidism during pregnancy, affecting the expected interaction with their environment. However, low IQ did play a part in the deficiencies presented in numerous studies leading to be the second deficiency with the highest frequency as mentioned in other studies (Deliatala, 2018). Other common deficiency were verbal comprehension, language, and memory. In a longitudinal study by Perez-Lobarto et al., (2015), applies this by researching children from the United States, nine to fifteen years of age, of mothers diagnosed with hypothyroidism during pregnancy, were found to recall fewer episodic details than control children in the context of an autobiographical memory interview, suggesting a memory impairment related to the hippocampus. Additionally, IQ, verbal expression/comprehension, attention, and verbal fluency abilities were positively and significantly associated with the third percentile of TS4 in this study.

This is prevalent for Hispanic populations to investigate, since according to a study by Gonzalez et al., 2019, out of the 9.8% that

met with the diagnosis criteria for Mild Cognitive Impairment (MCI) worldwide. From these, Puerto Ricans met the 12.9 % being the highest prevalence amongst the Latino groups in the study, followed by Cubans (8.0%). This could indicate that Caribbean-Hispanics represent a higher tendency than mainland Hispanics and Latinos (i.e., Central America). Therefore, children with mild cognitive impairment born to mothers with hypothyroidism during pregnancy could be treated inadequately due to lack of research on the effects of hypothyroidism during pregnancy and subsequent neurocognitive functions.

Conclusion

Thyroid hormones are crucial for the cycle of myelination continuing until adulthood, possibly affecting the offspring neurodevelopment (Aakre et al.,2017). In this SLR, 80% of articles reported that hypothyroidism affects the cognition on the offspring. The bulk of the literature examined points to an association between maternal hypothyroidism and adverse neurocognitive and neurodevelopmental outcomes in offspring and thus the importance of replication in other populations.

Most of the literature established the need for further research to evaluate neurocognitive functions such as attention, memory, motor functions in children with hypothyroidism or children born from mothers with hypothyroidism in other population such as Hispanic and Caribbean. There is a lack of experimental research in different subtypes of hypothyroidism children (i.e., congenital hypothyroidism, subclinical hypothyroidism, and Hashimoto's), considering discussed factors, research in this area is relevant. In Hispanic populations, exploring hypothyroidism in children is important since children with

congenital hypothyroidism were found to be most prevalent in Hispanic populations. For example, in a study conducted by Mintziori et al., (2015) found that the incidence of congenital hypothyroidism is 100% higher in Hispanic newborns than other ethnicities or races. Most of the investigations in this SLR were implemented by medical faculty, therefore a biopsychosocial approach that also takes upon a psychological distress and economic background, would be beneficial. Also, most of the studies only evaluated either neurodevelopment functions or intelligence, specific neurocognitive functions were insufficient. A neurocognitive profile is recommended in Hispanic populations to further understand the overall cognitive function of these children and prevent further complications.

There were limitations throughout this study. Investigators were unable to access socioeconomic data, genetic factors, and comorbid conditions in the literature since the inclusion criteria only involved hypothyroidism in pregnancy and neurocognitive functions. International databases were not searched, only accessible national databases such as Google Scholar, Research Gate, Psychology and Behavior, Pub Med and Psych Info were used. As well, the selection of the articles between the years 2005 and 2019 could limit the knowledge from other studies conducted earlier to 2005. This SLR addresses the importance of conduct research in this topic with Hispanics populations providing preliminary data for the association of hypothyroidism diagnosis during pregnancy and subsequent neurocognitive deficiencies in children. Future studies should provide data for the development of prevention and intervention programs for the Hispanic population, in conjunction with interdisciplinary health professionals input to address the needs of these offspring.

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Conflict of interest

There was no conflict of interest between the investigators.

Approval of the Institutional Board for the Protection of Human Beings in Research

This study is approved by the Institutional Review Board- Ponce Health and Sciences University (1908019532).

Consent or Assessment forms

No consent or assent form was distributed since this is an SLR.

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