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The other face of advanced paternal age: a scoping review of its terminological, social, public health, psychological, ethical and regulatory aspects

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BACKGROUND: There is a global tendency for parents to conceive children later in life. The maternal dimension of the postponement transition has been thoroughly studied, but interest in the paternal side is more recent. For the moment, most literature reviews on the topic have focused on the consequences of advanced paternal age (APA) on fertility, pregnancy and the health of the child.

OBJECTIVE AND RATIONALE: The present review seeks to move the focus away from the biological and medical dimensions of APA and synthesise the knowledge of the other face of APA.

SEARCH METHODS: We used the scoping review methodology. Searches of interdisciplinary articles databases were performed with keywords pertaining to APA and its dimensions outside of biology and medicine. We included scientific articles, original research, essays, commentaries and editorials in the sample. The final sample of 177 documents was analysed with qualitative thematic analysis.

OUTCOMES: We identified six themes highlighting the interdisciplinary nature of APA research. The 'terminological aspects' highlight the lack of consensus on the definition of APA and the strategies developed to offer alternatives. The 'social aspects' focus on the postponement transition towards reproducing later in life and its cultural dimensions. The 'public health aspects' refer to attempts to analyse APA as a problem with wider health and economic implications. The 'psychological aspects' focus on the consequences of APA and older fatherhood on psychological characteristics of the child. The 'ethical aspects' reflect on issues of APA emerging at the intersection of parental autonomy, children's welfare and social responsibility. The 'regulatory aspects' group different suggestions to collectively approach the implications of APA. Our results show that the field of APA is still in the making and that evidence is lacking to fully address the issues of APA. The review suggests promising avenues of research such as introducing the voice of fathers of advanced age into the research agenda.

WIDER IMPLICATIONS: The results of this review will be useful for developing policies and preconception health interventions that consider and include prospective fathers of advanced age.

Key words: advanced paternal age / paternal age / preconception care / scoping review / ethical and legal issues / psychosocial issues / policies / psychology / public health / social sciences

Introduction

There is a growing research interest in the effect of advanced paternal age (APA) on reproduction. Several reviews on the topic have been published focusing mostly on the relationship between advanced age and male fertility, pregnancy outcomes and children's health (Kühnert and Nieschlag, 2004; Sartorius and Nieschlag, 2010; Dain *et al.*, 2011; Sharma *et al.*, 2015; Nybo Andersen and Urhoj, 2017; Oldereid *et al.*, 2018; Brandt *et al.*, 2019). These studies show a consensus that APA is a risk factor of modest importance for several negative reproductive outcomes. The small numbers of children born to older fathers combined with the lack of research on the topic may bias the weighting of the risk of APA (Kühnert and Nieschlag, 2004). Also, this incomplete understanding of APA appears to be limited to APA's medical and biological dimensions. To produce a more comprehensive understanding of APA and in addition to existing reviews on APA, the objective of the present review is to explore aspects of APA other than medicine and biology. To attain the research objective, we conducted a scoping review, which is a common and robust technique, suited to synthesise a heterogenous body of work on an emerging topic.

Methods

We followed the five stages of the updated scoping review protocol developed by Arksey and O'Malley (Arksey and O'Malley, 2005; Levac *et al.*, 2010; Colquhoun *et al.*, 2014; Peters *et al.*, 2015; Tricco *et al.*, 2016). This work was carried out in compliance with PRISMA guidelines for scoping reviews (Tricco *et al.*, 2018) and is summarised in Fig. 1 (Moher et al., 2009).

Stage 1: Identifying the research question

The research question that guided this knowledge synthesis is: What is the state of knowledge of the literature on APA outside of its biological and medical dimensions? One corollary question followed: What are the knowledge gaps? This last question will be answered in the Discussion section.

Stage 2: Identifying relevant studies

We searched in academic databases covering the different fields of the interdisciplinary inquiry related to APA, namely health sciences, psychology, social sciences, humanities and law (Table I). Searches were carried out in August 2018 and updated in August 2019. We used advanced search options in the databases to combine two groups of key words (Table I). This strategy was used for all databases with two exceptions. In Scopus, the same strategy was applied with filters to obtain a sample of fewer than 2500 articles to be able to download the sample into a reference manager. This search was limited to articles in English and French, and excluded articles on animal populations. In

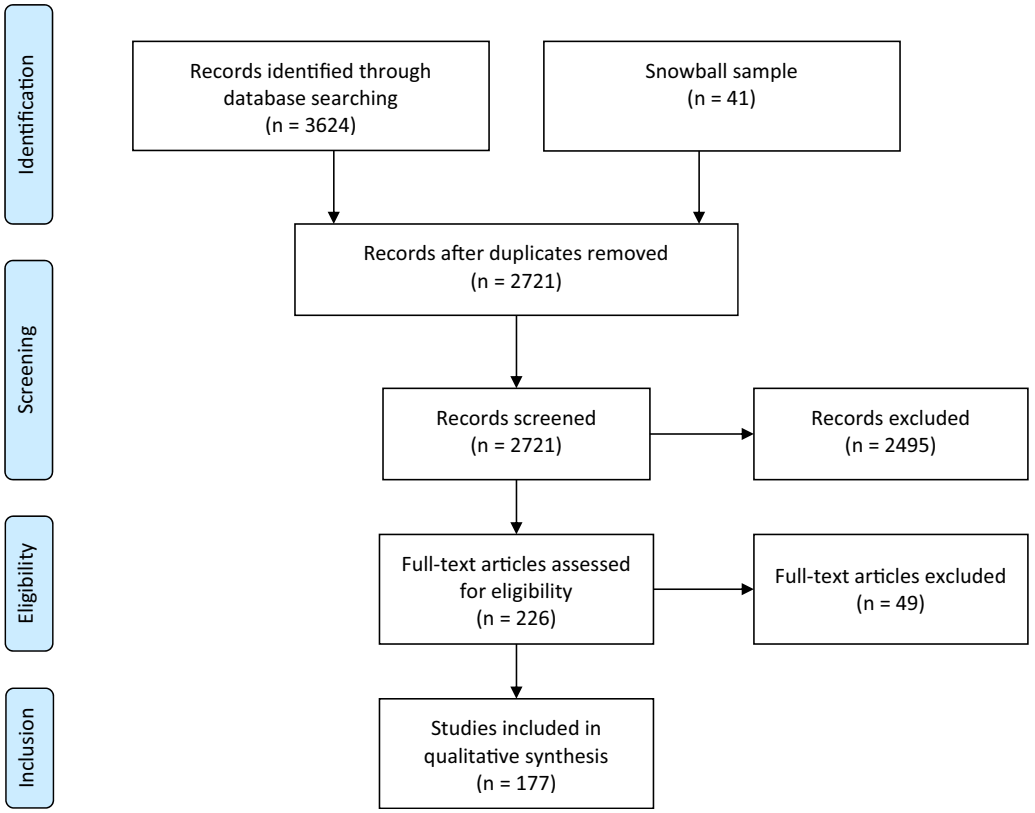

Figure 1. Prisma flowchart of article screening for a scoping review of aspects of advanced paternal age.

Table I Search strategies used in a scoping review of aspects of advanced paternal age.

Databases consulted	Search strategies
PubMed (Medline) CINAHL Embase HeinOnline JSTOR Web of Science	*Group 1 AND Group 2* Group 1 = ('advanced paternal age' OR 'late fatherhood' OR 'old* fatherhood' OR 'paternal age' OR 'postponed fatherhood') Group 2 = (ethic* OR social OR legal OR psychological OR policy)
Scopus	*Group 1 AND Group 2* Limitations: (French or English) AND (not bird OR mole OR deer OR drosophila OR horse)
PhilPapers	Keywords 'postponed fatherhood' 'paternal age' 'old* fatherhood' 'late fatherhood' 'advanced paternal age'

PhilPapers, we used keywords individually because it does not have an advanced search option. During data analysis, the sample was enriched with snowball sampling (Fig. 1).

Stage 3: Study selection

Eligibility criteria

Following Arksey and O'Malley (2005), we did not use strict inclusion and exclusion criteria (Table II). It is well accepted that scoping reviews—contrary to meta-analysis—do not seek to evaluate the validity of the items in the sample because of the heterogeneity of the sample in terms of methodologies and research paradigms (Arksey and O'Malley, 2005). For example, a bioethics theoretical essay can hardly be compared to a psychological correlation study. Regarding the population, the article had to address the reproductive situation of men of advanced age. Because there is no consensus on what constitutes APA, we did not place an age limit. This strategy allowed us to map the different definitions of APA. We excluded the literature on the biological and medical aspects of APA because that literature has been thoroughly reviewed before. Although the theme of 'psychological aspects of APA' overlaps with medical research, we preferred to include this category to produce the most complete portrait possible. In this category, correlation research with age as one of the many

Table II Inclusion and exclusion criteria for documents in the review.

Inclusion criteria	Exclusion criteria
• Types of documents: research articles, literature reviews, opinions, editorials, commentaries • Languages: English or French • The document considers APA as a subject of interest and discussion	• Types of documents: books, book chapters, grey literature, abstracts, news • Biological and medical dimensions of APA • APA treated as a secondary variable of analysis or a confounding variable

variables was excluded if it did not clearly address APA. We included scientific articles, original research, essays, commentaries and editorials in the sample. This diversity of items was chosen because of the interdisciplinary nature of the sample, ranging from health sciences to ethics. We excluded book chapters, books and published abstracts because it was not possible to systematically collect these items. We did not apply publication date limitations to evaluate the evolution of the debate through time.

Study selection

References of the articles collected during the Identification phase were integrated into EndNote (reference manager) and then into Covidence (an application designed to assist systematic reviewing) (Fig. 1). Using Covidence, we removed all duplicates. During the Screening phase, AM and VC screened the articles' titles and abstracts. For the Eligibility phase, we uploaded the PDF version of the article. The full-text eligibility was evaluated by SD and VC. During the Screening and Eligibility phases, articles for which there was disagreement surrounding eligibility were set aside for discussion to find a common agreement.

Stage 4: Charting the data

We extracted important information from the final sample into an Excel 'data charting form' (Arksey and O'Malley, 2005). The aim of this stage is to give a 'descriptive summary' of the literature (Peters *et al.*, 2015) (Figs 2 and 3).

Stage 5: Collating, summarising and reporting the results

The last stage led to the creation of a qualitative narrative account of the literature (Levac *et al.*, 2010) (Fig. 1). This was done using the inductive thematic analysis of the sample to identify the main patterns in the literature (Braun and Clarke, 2006; Thomas and Harden, 2008) combined with a deductive phase to answer the research question. We did three waves of coding (Thomas and Harden, 2008) with the assistance of NVivo software. Statements in the article related to our research questions were coded line-by-line. From this first wave of coding, we did a second wave to produce descriptive themes. A third wave refined the descriptive themes into analytical themes. Then, we organised the analytical themes into a response to the research question (see Results). The meaning of these results and their implications are analysed in the Discussion.

Results

Charting the data

Most items in the final sample of 177 (Supplementary Table SI) documents were published in the past 10 years ($N = 120$) (Fig. 2). The oldest document was published in 1969, but there is a noticeable increase in research production on APA after 2000. Most research projects on the topic are retrospective quantitative data analyses (Fig. 3). Qualitative and mixed methods are infrequently used.

Results synthesis

Six themes emerged from the analysis of the literature on APA: terminological aspects; social aspects; public health aspects; psychological aspects; ethical aspects and regulatory aspects.

Terminological aspects

Two subthemes characterise the terminological aspects of APA: the lack of consensus on the definition of APA, and the attempts to propose a working definition.

Lack of consensus on the definition of APA

The absence of agreement on the definition of APA is a common topic in the literature (Bessin, 2006; Toriello and Meck, 2008; Dain *et al.*, 2011; Nilsen *et al.*, 2013; Ramasamy *et al.*, 2015; Liebenberg *et al.*, 2016; Waldenström, 2016; Nybo Andersen and Urhoj, 2017; Oldereid *et al.*, 2018; Brandt *et al.*, 2019; Phillips *et al.*, 2019). The term 'older father' is ambiguous *per se* (Greenfeld, 2011). A suitable definition of APA in relation to a certain condition may not be relevant for another condition (Ramasamy *et al.*, 2015). For example, a definition of APA associated with risks for paediatric cancers may not be a reference for schizophrenia (Ramasamy *et al.*, 2015). Most articles in this review do not defined APA and a common strategy is to refer instead to age brackets (e.g. 21–30, 31–40, 41–50 years). Authors discuss if we should adopt a discrete cut-off point (Ramasamy *et al.*, 2015) or break down the category of APA into subpopulations (Wu *et al.*, 2016). This lack of definition has different clinical repercussions that affect and limit reproductive counselling and preconception health initiatives, such as engaging a patient–clinician discussion on APA (Ramasamy *et al.*, 2015; Phillips *et al.*, 2019).

Working definitions

Ramasamy *et al.* (2015) identified 32 studies using an age limit for APA. Their results show a variety of thresholds ranging from 35 to 50 years old (Ramasamy *et al.*, 2015). In the sample of the present

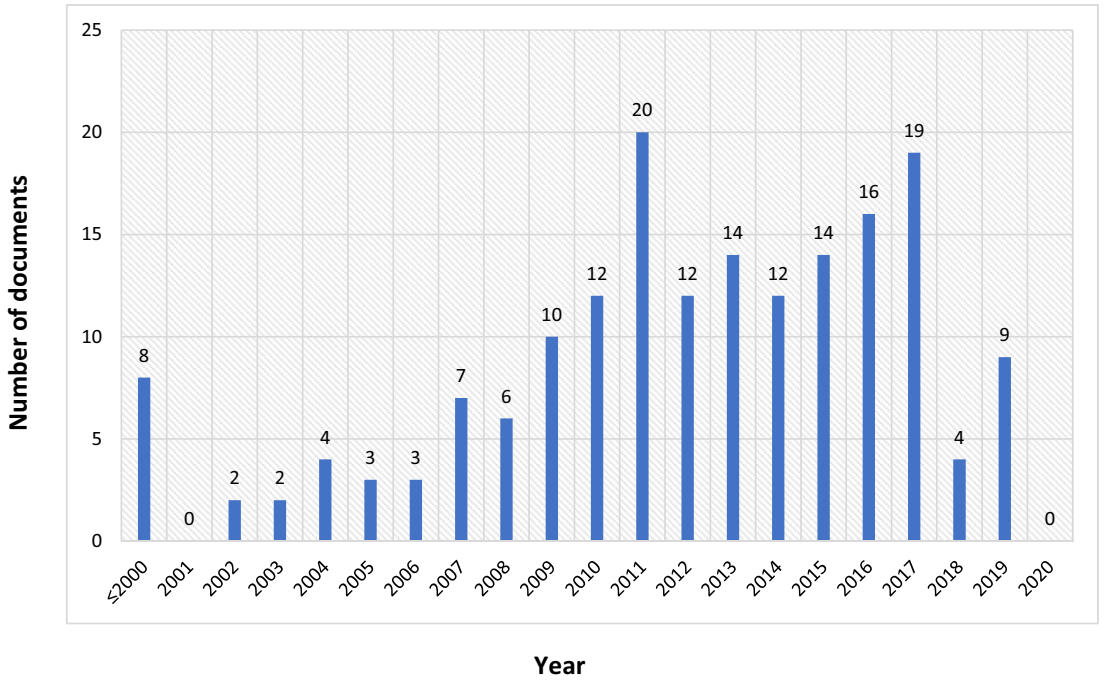

Figure 2. Number of publications per year for the final sample of 177 documents. The majority of articles were published in the past 10 years (*N*=120).

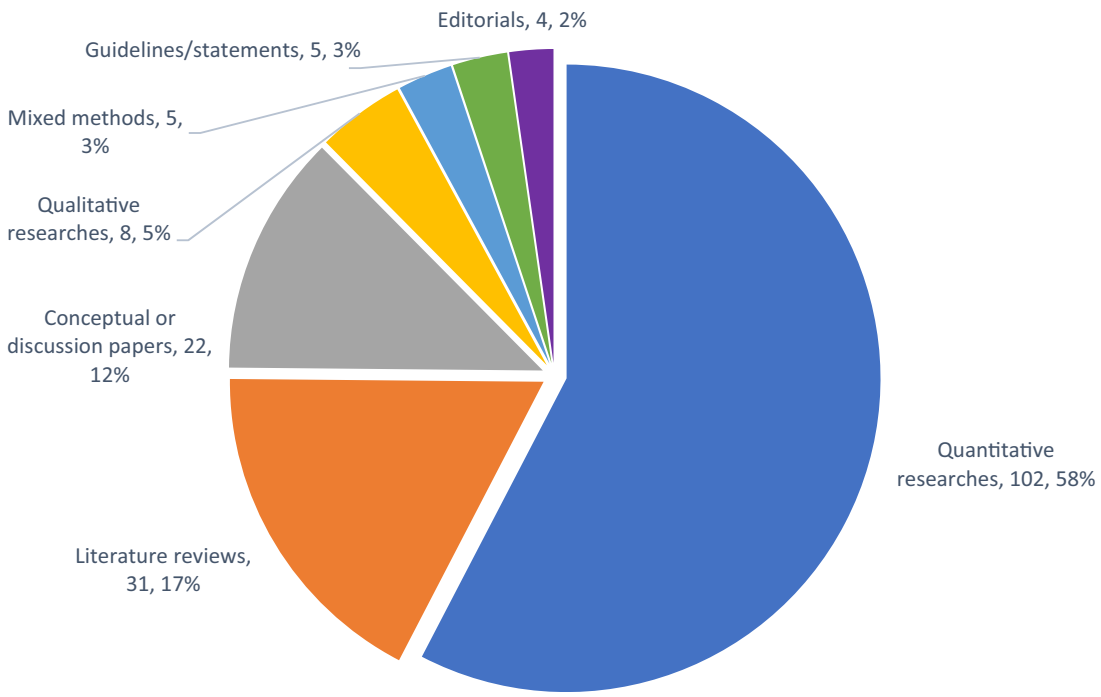

Figure 3. Types of publications in the sample. Values are *n*, percentage of the 177 total publications in the review.

review, different cut-off ages were used, most without any explanation of their choice, and with a tendency to define APA as ≥40 years (Table III). Nilsen et al. (2013) suggested that 35–39 years be considered 'APA' and more than 40 'very advanced age'. Dain et al. (2011) mentioned that greater attention should be given to men >60 to 70 years old by not systematically including them in age groups such as 'over 50'. An alternative to setting APA within a precise timeframe could be to refer to the upper quartile of the age distribution (Waldenström, 2016).

Social aspects

Three subthemes illustrate the social aspects of APA: the demographics of the postponement transition; the explanations of the transition and its cultural dimensions.

Demographics of the postponement transition

The postponement transition has been documented for both paternal and parental age, and sometimes it is impossible to disentangle one from the other. Authors have acknowledged the global nature of the trend towards reproducing later in life (Cedars, 2015). The trend has been studied in greater detail for groups of high-income countries (Sobotka, 2009; Brown, 2018), European countries (Mills et al., 2011; Mintziori et al., 2013) and specific countries such as Canada (Mill et al., 2016), Finland (Paavilainen et al., 2016), the UK (Bray et al., 2006; Wu et al., 2016) and the USA (Cedars, 2015; Khandwala et al., 2017). Taking a larger perspective, authors have mentioned that APA is not a new phenomenon in human history (Bessin, 2006; Nybo Andersen and Urhoj, 2017). It has been traditionally associated with larger families (Bessin, 2006). The low paternal age in the 1950s and 1960s gives the impression that the actual trend is of greater magnitude (Nybo Andersen and Urhoj, 2017). Some anticipate that the transition is far from over (Sobotka, 2009; Cedars, 2015).

Regarding the composition of the population of older fathers, Nilsen et al. (2013) criticised the idea of a homogenous group of 'well-established and resourceful individuals'. Their research showed that while men with high income were overrepresented in the group of fathers of advanced age, there were also men with low levels of education and who were unemployed in the group (Nilsen et al., 2013; Waldenström, 2016): according to Nilsen et al. (2013), the latter may find it more difficult to attach to the baby.

Table III Age cut-off for advanced paternal age.

Cut-off (years)	References
30 and over	Ben Itzchak et al. (2011)
32 and over	Van Balen (2005)
34 and over	Schytt and Bergström (2014)
35 and over	Agricola et al. (2016), Aitken (2014), Bajwa et al. (2011), Grigoroiu-Serbanescu et al. (2012), Phillips et al. (2019) and Waldenström (2016)
40 and over	Balasch and Gratacos (2012), Brandt et al. (2019), Brown (2018), Foutz and Mezuk (2015), Kaarouch et al. (2018), Liu et al. (2011), Malaspina et al. (2015), Mill et al. (2016), Paavilainen et al. (2016), Saha et al. (2009), Sigman (2017), Svensson et al. (2012), Svensson et al. (2013) and Toriello and Meck (2008)
45 and over	Bessin (2006) and Billari et al. (2011)
50 and over	Amato et al. (2013) and Schmidt et al. (2012)

Explanations of the transition

Four groups of factors have been used to explain why men reproduce later in life: medical, social, economic, as well as individual and interpersonal reasons. Other factors with the reverse effect of encouraging reproduction earlier in life have also been identified.

Regarding medical reasons, the literature names two main factors: first, the normalisation of contraception—more specifically the use of the contraceptive pill by women (Sobotka, 2009; Greenfeld, 2011; Mills et al., 2011; Mill et al., 2016), and second, the accessibility of ART, which increases the potential to reproduce later in life (Bray et al., 2006; Greenfeld, 2011; Zweifel, 2015).

The literature identified several social changes that occurred in the last decades that could affect when men start their family project. More specifically, authors have highlighted changes in the size of birth cohort (Bray et al., 2006), the changing status of women (Sobotka, 2009; Greenfeld, 2011; Mills et al., 2011), greater gender equity (Sobotka, 2009; Greenfeld, 2011; Mills et al., 2011), the rise of individualism as opposed to traditional family norms (Sobotka, 2009; Mills et al., 2011; Daar et al., 2016; Paavilainen et al., 2016) and the importance of higher education (Sobotka, 2009; Mill et al., 2016; Paavilainen et al., 2016), especially for women (Sobotka, 2009; Greenfeld, 2011; Mills et al., 2011).

Economic factors also explain the transition. Economic uncertainty and unemployment are frequently cited (Bessin, 2006; Sobotka, 2009; Mills et al., 2011; Mill et al., 2016; Paavilainen et al., 2016). The lack of supportive family–work balance policies could also play a role (Mill et al., 2016), as well as the inaccessibility of the housing market for young couples (Greenfeld, 2011).

The last factors are related to individual and interpersonal dynamics. Personal trajectories, such as migration, could delay the time of conception (Bessin, 2006). Identity issues and family background have also a role to play (Pennings, 1995; Waldenström, 2016). The difficulty of creating an intimate relationship strong enough for family building is often mentioned (Pennings, 1995; Sobotka, 2009; Paavilainen et al., 2016; Waldenström, 2016). Men may also prefer to postpone birth until they feel that their social, psychological and material situation is stable (Thompson and Lee, 2011). High divorce rates and unstable unions also play a role in delaying family building (Bessin, 2006; Greenfeld, 2011; Mills et al., 2011; Paavilainen et al., 2016). Other factors could be related to family building later in life, such as conceiving in a second relationship (Bessin, 2006; Greenfeld, 2011; Paavilainen et al., 2016). The tendency for men to overestimate their own fecundity can explain the postponement of the family building (Schytt et al., 2014). For single and gay men, the high cost of surrogacy mixed with cultural expectations of male parenthood may participate to the postponement of family building (Carone et al., 2017).

Certain factors can have the opposite effect and promote family building earlier in life such as the notion of the 'biological clock' and the awareness of the effect of reproductive age on the well-being of the future child (Sobotka, 2009; Roberts et al., 2011).

Cultural dimensions

APA culturally reflects the use of two standards between men and women—or 'double standard'—in terms of advanced age (Fasouliotis and Schenker, 1999; Banh *et al.*, 2010; Campbell, 2011; Ylänne, 2016). This narrative can be found in the different discourses in media, scientific research and society.

In the media, negative tones are more frequently expressed for older mothers than for older fathers, especially in the blaming (Campo-Engelstein *et al.*, 2018). The media presents older male celebrities becoming fathers as a growing trend, depicts them as good parents enjoying paternity (Ylänne, 2016), and frequently congratulates them (Campbell, 2011). This reference to celebrities has the effect of normalising APA (Ylänne, 2016). In comparison to women, the risks of APA are underrepresented in media coverage (Campbell, 2011). This situation reinforces the widespread assumption that the responsibility for reproduction is carried by the female partner (Campbell, 2011; Ylänne, 2016; Campo-Engelstein *et al.*, 2018). This assumption may change in the near future with the increasing social awareness of the link between paternal age and the child's health (Campo-Engelstein *et al.*, 2018).

The same double standard could be observed in the lower interest of scientific research for APA in comparison to advanced maternal age (Greenfeld, 2011; Almeling and Waggoner, 2013; Nilsen *et al.*, 2013; Alichniewicz and Michałowska, 2015; Ramasamy *et al.*, 2015; Hens, 2017). This double standard has been observed in the field of preconception health (Campo-Engelstein *et al.*, 2018), studies on the reproductive process (Phillips *et al.*, 2019), research on the underlying social factors of APA (Paavilainen *et al.*, 2016) and demographics (Sobotka, 2009). This situation could be partly related to the fact that men are less involved in preventative health and less prone than women to consult doctors for reproductive issues (Bonhomme, 2007; Phillips *et al.*, 2019). According to De Jonge, the actual understanding of the effects of APA may only be the 'tip of the iceberg' and the importance of the paternal contribution may be revised (De Jonge and Barratt, 2019).

From a social perspective, authors believe that the biological clock should not only be associated with aging women (Phillips *et al.*, 2019). The overemphasis on the mother's responsibility shows how the social conception of reproduction is grounded in gendered assumptions (Pennings, 1995; Fasouliotis and Schenker, 1999; Campbell, 2011; Hens, 2017).

Public health aspects

A less developed theme conceives APA as a public health problem. Because delayed parenthood has both health an economic consequences, it should be considered as a public health issue (Mill *et al.*, 2016; De Jonge and Barratt, 2019). Although the risks associated with APA are said to be quantitatively of low importance, authors anticipate that they will be amplified in the future with the postponement transition and the increase in the proportion of fathers of advanced age (Bray *et al.*, 2006; Smith, 2015; Urhoj *et al.*, 2017). One of the effects of the transition could be seen in the increasing demand for ART from men of advanced age (Nilsen *et al.*, 2013; Belaisch-Allart *et al.*, 2016; Klitzman, 2016).

Psychological aspects

APA has been associated with both negative and positive psychological consequences. These consequences are related to three subthemes: the child psychological conditions associated with APA; the psychological disadvantages of older parenthood for the child and the psychological advantages of older parenthood.

Child psychological conditions associated with APA

There is a vast range of literature statistically associating APA with a diversity of conditions with strong psychological implications for the child (Krishnaswamy *et al.*, 2009; Saha *et al.*, 2009; Aitken, 2014; D'Onofrio *et al.*, 2014; McGrath *et al.*, 2014; Malaspina *et al.*, 2015; Oldereid *et al.*, 2018) (Table IV). Another group of studies has pointed at the absence of association between the fathers' age and a smaller range of conditions (Table IV). Less frequent associations have suggested the positive impact of APA in terms of school performance and higher geek index (Shields and Hanneke, 2008; Janecka *et al.*, 2017).

To interpret these risks, many elements have to be considered. Authors suggest that, although the association with severe conditions is statistically significant, the overall risks remain low that a single, individual child develops these conditions (Kühnert and Nieschlag, 2004; Greenfeld, 2011; Wu *et al.*, 2016 Jennings *et al.*, 2017; Brown, 2018; Khandwala *et al.*, 2018). Several biases undermine the potential association between APA and a specific psychological condition (Khandwala *et al.*, 2018). Some studies mentioned the difficulty of disentangling the maternal effect from the paternal effect (Caplan and Patrizio, 2010; Braverman, 2017), and some chose to study the variable of 'parental age' instead (Croen *et al.*, 2007; Kolevzon *et al.*, 2007; Grether *et al.*, 2009; King *et al.*, 2009; Lopez-Castroman *et al.*, 2010; Menezes *et al.*, 2010; Shelton et al., 2010; Ben Itzchak *et al.*, 2011; Krishnaswamy *et al.*, 2011; Balasch and Gratacos, 2012; Parner *et al.*, 2012; Rahbar *et al.*, 2012; Idring *et al.*, 2014; Sandin *et al.*, 2016; Merikangas *et al.*, 2017). The negative neurocognitive effects of APA can be counterbalanced by the environmental advantage of having an older father (Svensson *et al.*, 2011). Some authors argue that the parental educational level should be considered a confounder or a mediator (Urhoj *et al.*, 2017). Authors suggest that the confounding effects of socioeconomic, environmental or family factors may explain or mitigate the association (Svensson *et al.*, 2011; Cedars, 2015; Carslake *et al.*, 2017). Others mentioned that the associations between APA and such conditions may be biased by the small number of cases and the paucity of research on the topic (De Jonge and Barratt, 2019). The age of the father is not always recorded in birth registries (Urhoj *et al.*, 2017) and there could be doubt regarding the paternity of the child (Urhoj *et al.*, 2017). With the postponement transition, authors predict that there will be more interest in the topic and this situation may change (Hudson, 2015; Smith, 2015; De Jonge and Barratt, 2019).

Psychological disadvantages of older parenthood

Another psychological dimension of APA is related to the negative effect of older parenthood. In the literature, the biggest issue is that children of older fathers may face the death of their father earlier in their lives (Pennings, 1995; Sobotka, 2009; Greenfeld, 2011; Zweifel *et al.*, 2012; Amato *et al.*, 2013; Zweifel, 2015; Daar *et al.*, 2016; Braverman, 2017; Carslake *et al.*, 2017). This is aggravated by the fact that men have a shorter life expectancy than women (Banh *et al.*, 2010). For example, men having a child at 65 years have 15.9 expected

Table IV Advanced paternal age and the mental health of the child.

Presence of an association	Conditions	References
Yes	Schizophrenia	Alichniewicz and Michałowska (2015), Bajwa et al. (2011), Billari et al. (2007), Bonhomme (2007), Brown et al. (2002), Byars and Boomsma (2016), Byrne et al. (2003), Dalman and Allebeck (2002), de Kluiver et al. (2017), Fountoulakis et al. (2018), Hubert et al. (2011), Hui et al. (2015), Liu et al. (2011), Malaspina et al. (2005), Miller et al. (2011), Naserbakht et al. (2011), Omranifard and Asadollahi (2009), Petersen et al. (2011), Sipos et al. (2004), Smith (2015), Sobotka (2009), Svensson et al. (2012), Svensson et al. (2013), Torrey et al. (2009), Tsuchiya et al. (2005), Wang et al. (2019), Wang et al. (2015), Wohl and Gorwood (2007), Wu et al. (2012) and Zammit et al. (2003)
	Paternal age-related schizophrenia	Lee et al. (2011), Liebenberg et al. (2016) and Rosenfield et al. (2010)
	Autism spectrum disorders	Alichniewicz and Michałowska (2015), Alter et al. (2011), Burd et al. (1999), Byars and Boomsma (2016), de Kluiver et al. (2017), Hultman et al. (2011), Liu et al. (2011), Lundstrom et al. (2010), Puleo et al. (2012), Reichenberg et al. (2006), Sasanfar et al. (2010), Smith (2015), Sobotka (2009), Tsuchiya et al. (2008) and Wu et al. (2017)
	Bipolar disorder	Fountoulakis et al. (2019), Frans et al. (2008), Grigoroiu-Serbanescu et al. (2012) and Smith (2015)
	Lower neurocognitive performance	Fahmy et al. (2017), Saha et al. (2009), Sobotka (2009) and Whitley et al. (2012)
	Behavioural problems	Aboobaker et al. (2019), Hehar et al. (2016), Maitra and Mukhopadhyay (2019) and (Weiser et al., 2008)
	Suicide and mortality	Axelsson and Lagerkvist-Briggs (1992), Miller et al. (2010), Miller et al. (2010) and Mok et al. (2017)
	Lower intelligence quotient	Alichniewicz and Michałowska (2015), Carslake et al. (2017) and Gajos and Beaver (2017)
	Neurodevelopmental disorders	Alichniewicz and Michałowska (2015)
	Psychosis	El-Saadi et al. (2004) and Foutz and Mezuk (2015)
	Eating disorders	Javaras et al. (2017) and Racine et al. (2014)
	Criminality	Kuja-Halkola et al. (2012) and Mok et al. (2017)
	Intellectual disability	Smith (2015)
	Alzheimer's disease	Sobotka (2009)
	Dyslexia	Sobotka (2009)
No	Cognitive disabilities	Arslan et al. (2014), Auroux et al. (2009), Cohen (2014), Edwards and Roff (2010) and Myrskylä et al. (2013)
	Bipolar disorder or one of its subtypes	Brown et al. (2013), Lehrer et al. (2016) and Weiser et al. (2019)
	Schizophrenia or one of its specific types	Ek et al. (2015), Miller et al. (2011), Tsuang et al. (2014) and Weiser et al. (2019)
	Eating disorders	Ahren et al. (2013)
	Psychotic-like experiences	Vreeker et al. (2013)
	Alzheimer's disease	Ptok et al. (2000)
	Psychiatric hospitalisation	Birtchnell (1969)

years of life and 11.2 of these in good health (Zweifel et al., 2012). This parental loss is considered a traumatic experience (Zweifel, 2015; Braverman, 2017) that is feared by offspring (Zweifel et al., 2012; Kocourková et al., 2015). Children have also a higher chance of being confronted with their parents' health decline and becoming caregivers early in life (Sobotka, 2009; Zweifel et al., 2012; Zweifel, 2015; Braverman, 2017). There is also a greater likelihood that the children of older fathers will never know their grandparents (Zweifel et al., 2012; Kocourková et al., 2015; Zweifel, 2015; Belaisch-Allart et al., 2016).

The age of the father could also affect parenting quality by making the father less able to meet the psychological and physical needs of the child (Daar et al., 2016). Older fathers may have less stamina to respond to the requirements of a growing child (Greenfeld, 2011; Shirani, 2013; Kocourková et al., 2015). Advanced age may also create an important generational gap between the parent and the child (Zweifel et al., 2012; Kocourková et al., 2015), which may explain the bad quality of interactions during adolescence (Shields and Hanneke, 2008). Children surveyed by Kocourkovà et al. (2015) stated that they would prefer having parents who had them before 30 years of age.

Psychological advantages of older parenthood

APA is not only related to negative psychological outcomes (Greenfeld, 2011; Myrskylä et al., 2017). The most cited advantage of

having an older father is that they tend to have a higher socioeconomic status than younger fathers, which has a direct effect on the child's well-being (Sobotka, 2009; Shirani, 2013; Kocourková *et al.*, 2015; Carslake *et al.*, 2017; Myrskylä *et al.*, 2017; Barclay and Myrskylä, 2018). Older fathers tend to have a better behavioural profile (Myrskylä *et al.*, 2017; Nybo Andersen and Urhoj, 2017), better parenting skills (Shields and Hanneke, 2008; Greenfeld, 2011; Kocourková *et al.*, 2015), greater behavioural involvement with children (Mare and Tzeng, 1989; Cooney *et al.*, 1993; Mac Dougall *et al.*, 2012), more stable parenting relationships (Sobotka, 2009; Greenfeld, 2011; Kocourková *et al.*, 2015) and more maturity (Stelle and Sheehan, 2011). According to Gardiner *et al.*, this may explain the lower risk of injury of children of older fathers. Another advantage of older fathers is that their children are said to be more desired (Sobotka, 2009; Zweifel *et al.*, 2012).

Ethical aspects

APA raises several ethical issues that have, for the moment, not received 'serious ethical scrutiny' (Smith, 2015). These issues can be divided into five subthemes: the opposition between the parent's autonomy and the well-being of the child; the balance between risks and benefits of APA; issues at the intersection of APA and discrimination; the definition of responsible parenthood and issues related to the management of APA.

Parent's autonomy and the well-being of the child

The first subtheme relates to the opposition between the parents' autonomy and the well-being of the future child. Authors discussed whether it would be acceptable to limit the parents' reproductive autonomy on the grounds of the best interest of the child (Belaisch-Allart *et al.*, 2016; Klitzman, 2016; Braverman, 2017). More precisely, could the well-being of the child justify that we collectively impose an age limit to access ART? Reproductive autonomy is a strong principle, which makes it difficult to interfere in parental decision-making (Braverman, 2017). The principle leads to tough dilemmas for health professionals (Klitzman, 2016). Health professionals interviewed by Klitzman (2016) mentioned that the clinical decision-making process with patients offers a space to negotiate the tension between the interests of the parents and those of their future child.

Balance between risks and benefits of APA

Another ethical issue discussed in the literature consists in finding the right balance between the advantages and disadvantages of APA (Bray *et al.*, 2006; Sobotka, 2009; Greenfeld, 2011; Alichniewicz and Michałowska, 2015; Smith, 2015; Braverman, 2017). On one hand, we must consider the adverse outcomes of APA for the health of the child, the father and the mother (Bray *et al.*, 2006). On the other hand, we must consider the psychosocial and environmental benefits of having an older father (Bray *et al.*, 2006). Depending on the answer to this question, authors suggest (or not) actions to limit the negative outcomes of APA, such as promoting sperm banking early in life (Smith, 2015).

APA and discrimination

APA brings forward discrimination issues. Is the present attitude towards APA an illustration of sexism, ageism or ableism?

APA intersects with sexism through the unfair attribution of burdens to older mothers in comparison to older fathers. Gender equality is important and the same standard should be applied for men and women (Banh *et al.*, 2010; Billari *et al.*, 2011). There should be fairness in the reproductive scenarios offered to both sexes (Daar *et al.*, 2016). According to some, men should be included in the reproductive counselling and their age should be a reason to propose prenatal genetic testing (Hens, 2017), and an age limit for access to ART should apply to both sexes (Zweifel *et al.*, 2012). Denying women access to safe ART or insurance coverage accessible for men of the same age is seen as unfair (Smajdor, 2008; Amato *et al.*, 2013). Through various health interventions (e.g. prenatal testing, preconception health, counselling, sperm freezing), men should be made responsible for their reproductive contribution (Almeling and Waggoner, 2013; Hens, 2017; Campo-Engelstein *et al.*, 2018). These measures would contribute to a more comprehensive and inclusive understanding of how the health of the foetus is affected by parental age at conception (Smajdor, 2008; Campbell, 2011; Hens, 2017; Campo-Engelstein *et al.*, 2018).

Ageism is another form of discrimination that could be associated with APA. The ageist critique stipulates that limiting reproduction because of APA implies that older people are denied parenting because of their age. The assumption is that there are no objective reasons for doing so. For centuries, grandparents have been taking care of their grandchildren without serious negative effects (Pennings, 2013). From that perspective, it is difficult to defend that children will be harmed by older parents (Caplan and Patrizio, 2010; Amato *et al.*, 2013; Daar *et al.*, 2016).

A similar argument can be found in the ableist critique. Should older fathers be treated the same way as disabled people, single parents or people with genetic condition histories (Braverman, 2017)? Any attempts to limit reproduction on the basis of APA should be consistent with other policies (Pennings, 2013; Braverman, 2017). For example, if we want to limit reproduction because of the limited life expectancy of older fathers, we must consider that people can reproduce regardless of their life expectancy (Amato *et al.*, 2013). For example, patients with cancer, although having a limited life expectancy, may have access to ART and techniques of fertility preservation (Banh *et al.*, 2010; Pennings, 2013).

Definition of a responsible parenthood

Another ethical question raised by APA is whether having a child later in life can be considered as responsible parenthood. Obviously, APA is not tantamount to 'child abuse', but would it generate 'suboptimal future childhood experiences' (Klitzman, 2016)? If we consider parenthood not as a right but as a commitment, what would responsible parenthood imply (Pennings, 1995)? Part of the explanation of the differential attitude towards late parenthood for men and women may lie in the idea that men and women are not seen as making the same commitment (Fasouliotis and Schenker, 1999). One answer is that a responsible parent has the minimal duty to accompany his child until it reaches maturity, in other words, until it becomes 18 years old (Pennings, 1995). Age cut-offs could be fixed at the mean age of when a person becomes incompetent (either physically or mentally) minus 18 years (Pennings, 1995).

Management of APA

The last group of issues relates to different dimensions of how to deal with APA. It has been observed that APA creates moral uncertainty, surprise and embarrassment for providers (Belaisch-Allart et al., 2016; Klitzman, 2016). They question themselves how to react when facing the population of older fathers: should we fix an age limit and how should this limit be established (Klitzman, 2016)? Sometimes the age of an older father is discussed during staff meetings in a case-by-case manner (Belaisch-Allart et al., 2016). During these discussions it is not clear which criteria should be given priority (Klitzman, 2016)? Who should make the decision (Klitzman, 2016)? How should the results be shared with the patient (Klitzman, 2016)? From a broader perspective, others asked whether it is ethical to advertise fertility programmes to older men and whether the treatments should be covered by public health insurance (Caplan and Patrizio, 2010).

Regulatory aspects

To respond to the different consequences of APA, several mechanisms have been proposed: fixing an age cut-off for ART; integrating APA into preconception health counselling; making prenatal genetic screening a condition for APA; offering sperm freezing programmes for age reasons and developing social policy incentives.

Age cut-off for ART

Imposing an age limit for ART is the most debated measure to respond to APA (Menon et al., 2015; Belaisch-Allart et al., 2016; Klitzman, 2016). It is not clear what the physician should do (Klitzman, 2016). People also question how the limit should be set (Belaisch-Allart et al., 2016). Should we limit access to ART or exclude the treatments from public funding plans (Belaisch-Allart et al., 2016)?

The father's age is rarely mentioned in laws and guidelines (Ramasamy et al., 2015; Belaisch-Allart et al., 2016; Klitzman, 2016). One exception is Germany where the age limit for ART is 50 years (Belaisch-Allart et al., 2016). Some recommendations have been made in reference with other parenting situations. The American Society for Reproductive Medicine recommends that sperm donation be made before 40 years (Jennings et al., 2017). In the UK, the British Andrology Society also recommends 40 years for sperm donation, but the legal age limit is 45 years (Jobling, 2014; Jennings et al., 2017). For adoption, the maximum age is between 40 and 50 years, depending on the country (Billari et al., 2011).

Empirical research on APA has highlighted different suggestions for age cut-offs. In one study in France, a small majority of medical professionals wanted a law setting a limit to access ART at 55 years and the majority wanted to limit insurance coverage of ART at 53 years (Belaisch-Allart et al., 2016). Billari and colleagues' analysis of European Social Survey data suggests that the paternal age deadline according to the general population should be around 47.3 years old (Billari et al., 2011).

Different strategies have been suggested to determine the limit. One strategy is that a least one partner must be under 55 years old (Pennings, 2013; Klitzman, 2016). Others suggest adding up both parents' ages (Belaisch-Allart et al., 2016; Klitzman, 2016). This cumulative age can be used to set a cut-off at, for example, 100 years (Klitzman, 2016). Some suggested taking into consideration the difference between the age of the partners (Belaisch-Allart et al., 2016). Others proposed setting soft limits that could be adapted to each couple (Klitzman, 2016). Otherwise the age cut-off could be a function of the healthy life expectancy (Pennings, 1995, 2013), or the biological condition of the sperm (Nybo Andersen and Urhoj, 2017).

There is also the question of how to set the limit? Who should decide: patients, doctors, the clinic, a hospital committee—e.g. the ethics committee or the parliament (Pennings, 2007; Klitzman, 2016)? Should providers follow their gut feelings, take into account public opinion, or design evidence-based policies (Klitzman, 2016)?

Others argue that we should not set an age limit (Belaisch-Allart et al., 2016; Klitzman, 2016). Clinicians are afraid that setting a limit might result in complaints and discrimination (Belaisch-Allart et al., 2016; Klitzman, 2016).

Preconception health counselling

The effects of paternal age are rarely discussed with patients (Ramasamy et al., 2015) and it is not clear how to offer proper counselling for APA (Brenner et al., 2009). Discussing the effect of the age of the male partner (Toriello and Meck, 2008; Cedars, 2015; Daar et al., 2016; Gajos and Beaver, 2017) and of older parenting (Amato et al., 2013) is recommended. All adults of reproductive age should receive counselling on the risks of APA to make an informed reproductive decision (Schmidt, 2010; Mintziori et al., 2013; Ramasamy et al., 2015; Wu et al., 2016; Brandt et al., 2019; De Jonge and Barratt, 2019; Phillips et al., 2019). It should take the form of a comprehensive discussion that encourages reflection about the impact their reproductive choice might have on their future child (Liu et al., 2011; Mintziori et al., 2013; Braverman, 2017). APA should be considered as a preconception health issue and included in the reproductive life plan (Brown, 2018). Education and counselling of APA patients should include: parental loss, parenting at an advanced age, increased genetic risks and infertility (Schmidt, 2010; Braverman, 2017; Khandwala et al., 2018). This counselling is an important part of responding to the widespread overestimation of the ability to reproduce at any age (Schmidt, 2010; Klitzman, 2016).

Genetic counselling and screening

Although there are no current guidelines (Toriello and Meck, 2008), some proposed offering prenatal genetic counselling and screening for paternal age (Yazdekhasti et al., 2016; Brandt et al., 2019). Counselling could address the risk of infertility and of miscarriage associated with APA (Brandt et al., 2019). Screening could be used to detect chromosomal abnormalities associated with APA (Jennings et al., 2017; Kaarouch et al., 2018), *de novo* mutations (Smith, 2015; Hens, 2017; Brandt et al., 2019) and DNA fragmentation (Kaarouch et al., 2018). According to Kaarouch et al.(2018), men over 40 years should undergo systematic screening. The inclusion of APA into a screening programme is perceived as a simple measure that could be facilitated with the introduction of whole-genome screening and non-invasive prenatal diagnosis (Hens, 2017; Brandt et al., 2019).

Sperm freezing programme

Sperm cryopreservation for young men is another solution proposed to respond to APA (Cedars, 2015; Hudson, 2015; Smith, 2015; Wu et al., 2016; Hens, 2017; Jennings et al., 2017; Phillips et al., 2019). This measure raises ethical and legal concerns (Jennings et al., 2017) and, according to Hens, is facing more resistance than elective egg freezing (Hens, 2017).

Proponents of this scenario ground their position on few claims. Sperm banking will lower the risk of disorders associated with paternal age (Hudson, 2015; Smith, 2015; Hens, 2017). It will be part of the social responsibility towards delayed reproduction (Phillips *et al.*, 2019).

Practically, it should be done when the man is young, ideally from 18 years old (Smith, 2015) and before his 35th birthday to limit the harm associated with APA (Phillips *et al.*, 2019). To guarantee success and accessibility, state-funded infrastructure, along with educational and publicity approaches to encourage men to participate, would be needed (Smith, 2015). Otherwise, it could be offered as a premium insurance service (Hudson, 2015).

Several arguments have been developed against sperm freezing for age reasons. The risk of genetic disorders is (very) low and does not increase enough to suggest banking (Cedars, 2015; Hens, 2017; Jennings *et al.*, 2017). Gamete freezing will go against the exhortation not to postpone reproduction, it will be costly, and it will promote an artificial approach to reproduction (Hens, 2017; Jennings *et al.*, 2017). The recourse to cryopreservation can have a deleterious effect on sperm parameters thus increasing the use of IVF/ICSI (Jennings *et al.*, 2017). ART could have also negative outcomes on the future child's health (Hudson, 2015). Finally, we need to think about the long-term implication of this large-scale storage (Cedars, 2015).

For the moment, sperm freezing for age reasons is still a marginal market in the gamete banking industry, and its implications have not been fully evaluated (Hudson, 2015). Although futuristic, some anticipate that it will receive more attention in the future (Wu *et al.*, 2016; Phillips *et al.*, 2019).

Social policy incentives

The last measures regroup educational, social and economic policies that can be applied to reverse the trend towards reproducing later in life (Mill *et al.*, 2016; Bhasin *et al.*, 2019). These measures can work on two aspects: 'reordering life course events' and 'shortening different phases of life' (Sobotka, 2009). The literature on APA refers to policies that promote more flexible labour markets and work–family balance (Bray *et al.*, 2006; Sobotka, 2009; Schmidt, 2010; Mills *et al.*, 2011; Mill *et al.*, 2016); more substantive family benefits (Bray *et al.*, 2006; Mills *et al.*, 2011); access to infertility treatment (Sobotka, 2009); affordable and accessible housing as one of the most important precondition for parenthood (Sobotka, 2009; Mill *et al.*, 2016); available child care (Sobotka, 2009) and arrangements in the educational system for parents (Mills *et al.*, 2011). These policies should reflect the heterogenous nature of contemporary lifestyles (Sobotka, 2009). Health promotion and education campaigns to develop public awareness regarding the issues of APA and preconception health have been suggested (Bray *et al.*, 2006; Miller *et al.*, 2011; Schmidt *et al.*, 2012; Agricola *et al.*, 2016; Bhasin *et al.*, 2019). It can work from a prevention perspective (Compton, 2004), and it will help counter men's lack of knowledge regarding reproduction (Daniluk and Koert, 2013).

Discussion

Principal findings

This review suggests that APA is a multidisciplinary field of research still in the making. For the moment, the concept of APA is not a fully useful tool for effective health interventions. We do not consider the concept of APA to be flawed, but—to use an expression from science and technology studies—we are witnessing its blackboxing (Latour, 1987). In other words, there is some evidence on APA, but the concept is not yet an operational construct. In this review, we showed that the lack of consensus on the definition of APA undermined our understanding of the implications of APA in terms of social, public health, psychological, ethical and regulatory aspects. This situation could be partially explained by the lack of priority given to APA research stemming from the shared idea that the negative outcomes of APA are, overall, modest (Jennings *et al.*, 2017; Oldereid *et al.*, 2018). This conclusion follows other studies (Sartorius and Nieschlag, 2010; Ramasamy *et al.*, 2015), but the present review also suggests that there is an explicit lack of data on the subjective dimensions of APA.

New avenues of research

To date, research has focused on biological mechanisms and their potential negative outcomes, while neglecting the experiences of late fatherhood. Alongside this substantial gap, other future research avenues emerged from the review.

Terminological aspects

The only consensus on APA is that there is no consensus on its definition (Ramasamy *et al.*, 2015). Our review suggests that we could develop a more complex comprehension of APA. Two alternatives emerged from our data.

The first alternative tackles the limits of APA as a fixed variable—either a discrete number or an interval. The premise is that advanced age has two faces—a social one and a biological one (Tsuchiya *et al.*, 2005; Boivin *et al.*, 2009; World Health Organization, 2015; Nybo Andersen and Urhoj, 2017)—but both notions of age are not fixed *a priori*. In biological terms, what is considered 'APA' in correlation with the prevalence of a specific disease may not be the age threshold for another disease (Ramasamy *et al.*, 2015). In social terms, the definition of 'advanced age' changes through time. Cultural norms on parental age have changed since the last century (Braverman, 2017). In that sense, it is clear that APA is a norm regarding some biological traits that a certain society, at a certain time, considers old for a certain group of reproducing males (Billari *et al.*, 2011). One alternative suggested in the literature could be to conceive APA as a process rather than a discrete or stratified variable, and refer to '*advancing paternal age*' (Ek *et al.*, 2015). This concept may be less rigorous in determining a reference threshold, but it may grasp a more fluid conception of age, blending both the biological and the social.

The second alternative reflects the difficulty to make a clear-cut distinction between the sexes' effect on reproduction outcomes. One reason is that reproduction can be conceived as an equation (Inhorn *et al.*, 2009; Almeling and Waggoner, 2013). Traditionally, this equation had two variables: female and male. Today, it is not difficult to develop a richer typology of variables, but it still appears that the effect of age on conception, gestation and the future child is a complex set of entanglements and interactions of parental factors (Wu *et al.*, 2017; Oldereid *et al.*, 2018). For that reason, this review points out a research trend towards the use of 'advanced *parental* age' (Schmidt *et al.*, 2012). This line of research will allow us to evaluate the combined effect—either additive or multiplicative—of both partners' age

(Nilsen et al., 2013). It will have the ethically valuable consequence of distributing the moral responsibilities associated with advanced reproductive age more fairly between genders (Hens, 2017). It also offers a perspective on reproductive age as a relational concept.

Social aspects

Regarding the social aspects theme, our analysis follows other literature reviews. These reviews show that APA is not a new phenomenon *per se*, while stressing the unique combination of medical, social, economic and interpersonal factors that characterise the present trend towards APA (Mills et al., 2011; Schmidt et al., 2012). One of the important particularities of our times may be the sociocultural transformation towards more inclusive parental roles (Cutas et al., 2018). In complement to these macro factors explaining the postponement transition, we can quote studies that characterise the population in greater detail (Van Balen, 2005; Bessin, 2006; Roberts et al., 2011; Nilsen et al., 2013; Schytt and Bergström, 2014). To continue this line of research, we must respond to the scarcity of information on the identities, motives and trajectories of fathers of advanced age. A similar conclusion has been made by Jamieson et al. (2010) on the social aspects of the reproductive life of men of all ages. More qualitative research would build more understanding around how social factors interact with personal experience. Couples' dynamics may also play an important role (Schytt, 2014). These new studies will help validate the demographic macro-factors that are usually cited to explain the postponement transition.

Psychological aspects

Our review also identified the absence of fathers' subjective perspectives on APA in the psychological literature. The literature essentially addressed mental health issues of APA from the perspective of the children of fathers of advanced age. From this main angle on children's health, most research considers APA through the transmission of congenital characteristics or from an environmental perspective (Boivin et al., 2009; Zweifel et al., 2012; Zweifel, 2015). Our review revealed that a great deal of research needs to be done on these topics, mostly by moving from correlation studies to cohort studies, but it also underlined the paucity of works on other aspects of family life. Mac Dougall et al. (2012) conducted one of the few qualitative studies on the perception of advantages and disadvantages of first-time parenting after 40 years of age. Exploring this underdeveloped perspective may lead to studying parental relationships from fathers' perspectives (Stelle and Sheehan, 2011; Shirani, 2013). This may allow us to understand how fathers compensate for age limitations, and how they build significant relationships, specific parental identities, etc.

Ethical aspects

The ethical reflection on APA also shows the absence of the fathers' voices. Two lines of ethical reasoning emerge from the literature. The first considers the ethics of APA in terms of standard perinatal ethics (Chervenak and McCullough, 2015). In other words, the ethic of APA is framed as the responsibility of healthcare providers to find a balance between the future child's well-being and the parents' reproductive autonomy in fulfilling their family project (Klitzman, 2016; Braverman, 2017). The second frames APA as a justice problem in terms of fair distribution of parental responsibilities between gendered roles (Hens, 2017). We agree that both lines are valid, but, again, fathers' voices are missing in both reflections. To refine these perspectives, it could be interesting to add qualitative research on the attitudes and perspectives of older fathers. One fruitful avenue could be to start from fathers' perspectives and analyse their moral lives in terms of their relationships with their families and communities (Taylor-Sands, 2013). It could also be relevant to look at the decision-making process and how medical interactions take place. This approach would provide us with a more nuanced understanding of fathers' experiences. It may offer an alternative to the framing of fathers of advanced age as men who overestimate their reproductive capacity, increasingly inspired and legitimised by positive late celebrity-father examples in the media.

Regulatory and public health aspects

Jennings and collaborators' review (2017) acknowledges the uncertainty surrounding the need for health interventions or policies addressing APA and the postponement transition. This uncertainty highlights the divergence between those who consider the risks of APA to be minor (Jennings et al., 2017) and those who see APA as a public health issue that will weigh down future generations (Smith, 2015; De Jonge and Barratt, 2019). Facing this uncertainty, our review suggests that there is a middle ground between these two scenarios. It seems that some evidence is available and that we should follow a gradation of interventions in function of the level of understanding of the issues. For the moment, evidence tends to recommend involving fathers in prenatal education and preconception health (Schmidt et al., 2012; Mill et al., 2016). This will help in responding to the lack of knowledge of both the public and healthcare providers regarding the effects of age on reproduction (Daniluk and Koert, 2013; García et al., 2017). Research on men's reproductive decision-making will certainly help fine-tune these interventions (Shirani, 2013). Other interventions outside of education, such as an age cut-off for ART or sperm freezing for age reasons, may be seen as steps that need further evidence to be deemed relevant.

Explaining the blackboxing

What we referred to as the blackboxing of APA can be related to two factors. The first factor is that the actual postponement transition is an ongoing social experiment. This trend is relatively recent and the cohort of children of men of advanced age is still small. Data are even scarcer regarding the oldest group of fathers such as those over 50 years (Dain et al., 2011). Without sufficient data, it is hard to make strong conclusions regarding the nature of APA. The second factor is social. Men of all ages have a secondary role in terms of reproduction (Inhorn et al., 2009). On one hand, they do not consult healthcare providers for reproductive issues (De Jonge and Barratt, 2019). This has the effect of making their needs less visible. On the other hand, they are less studied as reproductive agents (Jamieson et al., 2010). This social dynamic could be associated with what Daniels calls 'reproductive masculinity' (Daniels, 2006). According to Daniels, four assumptions can explain this lack of visibility of reproductive issues: men are assumed to have a secondary role in reproduction; men are assumed to be less vulnerable to reproductive harm than women;

men are assumed to be capable of fathering their own child; men are assumed to be distant from the health problems of their child (Daniels, 2006). Our hypothesis is that advanced-age reproductive masculinity follows these four assumptions.

Strengths and weaknesses of the study

One of the main strengths of this review is its ability to offer a thorough overview of APA research. It offers a synthesis of perspectives and ideas that complements existing reviews on the medical, biological and epidemiological aspects of APA. In that sense, it points at the interdisciplinary nature of the research on APA. This approach is of great help for policy building.

A first weakness of the study is the lack of a common definition of APA. It is possible that we missed articles that referred to APA only by using ranges of age (e.g. 5-year ranges). We could have missed other studies because of the ambiguous nature of 'advanced parental age' sometimes erroneously referring to women only. A second weakness relates to the scoping review methodology's inability to evaluate evidence and fully integrate authors' own acknowledged research limits. Contrary to meta-analysis, the interdisciplinary nature of our articles' samples prevented us from being able to compare the articles' methodologies. Also, because we included more reflexive papers, it was not possible to distinguish primary research from secondary analysis and commentary. For the same reasons, we were not able to analyse the bias of each study. A third weakness is that we were unable, for lack of resources, to conduct the optional sixth stage of the scoping review, 'Consultation Exercise' which would have consisted of discussing the results with a panel of experts (Arksey and O'Malley, 2005; Levac *et al.*, 2010).

Questions to be answered in future research

The first point to answer relates to the lack of definition of APA. This lack of definition has an impact on the way we do research. By considering the complexity of naming and conceptualising APA, a future call would be to find a consensus on the definition of the plethora of terms: APA, advanced parental age, paternal aging, advanced parental aging, delayed fatherhood, late paternity, late parenthood, advancing adoptive paternal age, etc. We believe that researchers interested in the topic could develop a common glossary to clarify and better codify the use and complementarity of each concept.

The second point is the lack of clarity surrounding the risk APA poses for the future child's well-being. This situation has a direct impact on how difficult it is to weigh the issues of APA in terms of ethics, policy, public health, etc. It makes it hard to determine which intervention should be prioritised. And we do not know yet if our current understanding of the risk is not biased by the lack of research on the topic.

The last point relates to the lack of empirical research on the attitudes, perspectives and values of fathers of advanced age. As suggested earlier, the lack of social understanding of this population may have direct consequences on the biological study of the phenomenon. It has also direct consequences on the nature and characteristics of any comprehensive interventions trying to promote sustainable parenthood (Mills *et al.*, 2011).

Conclusion

This scoping review presents APA as a multidisciplinary field of research in the making. Although many uncertainties remain about the nature of APA, there is a growing field of research inquiring into its social, public health, psychological, ethical and regulatory aspects. This field shows promising avenues of research, *inter alia* by giving a voice to fathers of advanced age. Research on APA is crucial to adequately respond to the postponement transition and to tailor appropriate interventions to mitigate its less desired outcomes.

Supplementary data

Supplementary data are available at *Human Reproduction Update* online.

Data availability

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

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Authors' roles

V.C. and G.P. conceived the design of the review. They conducted the preliminary reviews and completed the full review with S.D. and A.M. All co-authors contributed to the analysis of the data, the writing and the revision of the manuscript. They all approved the final version of the manuscript.

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Conflict of interest

The co-authors certify that they have no financial, professional or personal conflicting interests with the present project.

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