

# Growing up Gravettian: Bioarchaeological perspectives on adolescence in the European Mid-Upper Paleolithic

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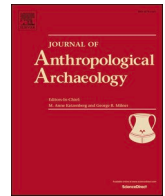
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# Growing up Gravettian: Bioarchaeological perspectives on adolescence in the European Mid-Upper Paleolithic

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## ABSTRACT

Adolescence is a stage of development unique to the human life course, during which key social, physical, and cognitive milestones are reached. Nonetheless, both the experience of adolescence and the role(s) of adolescents in the past have received little scholarly attention. Here we combine a broad interpretative framework for adolescence among prehistoric hunter-gatherers with direct bioarchaeological (burial) data to examine the lives of teenagers in the European Mid-Upper Paleolithic or Gravettian (~35–25,000 years ago). Comparisons of the burial practices of individuals of different age classes (infant, child, adolescent, adult), as well as between adolescents who died at different ages, reveal some patterns related to adolescence in these communities, including 1) fewer distinctions based on sex among adolescents compared to adults; 2) differences between the sexes in age-at-death within our ‘adolescent’ age class—with females disproportionately dying later—potentially indicating high risks associated with first pregnancy; 3) distinctions in grave goods and diet among adolescents of different ages-at-death which we tentatively interpret as providing an emic perspective on the beginning of adolescence as defined by Pleistocene hunter-gatherers. Nonetheless, our analysis supports long-standing models of a distinct, continent-wide European Mid-Upper Paleolithic funerary tradition, with the burial data expressing social cohesion, rather than social distinctions, between age classes.

## 1. Introduction

Adolescence is a stage of development that is unique to the human life course and universal across human societies. Adolescence is a dual biological and social phenomenon; the time during which teenagers<sup>1</sup> begin to prepare for adult life, driven by important biological and cognitive developments that occur with the onset of puberty. Research on the biological and social facets of adolescence in modern contexts identifies both the distinctiveness of the teenage years and their interdependence on the preceding and succeeding life stages of childhood and adulthood (Schlegel & Barry 1991). Accordingly, the study of adolescence has much to offer to our wider understanding of all human societies and of the changing social role(s) of individuals throughout their lifetime—past and present.

While recent initiatives have prompted increased research into the study of adolescence in the past (e.g., SSCIP 2019), adolescents and adolescence are relatively understudied compared to children and

childhood *sensu stricto*. This gulf is particularly notable in the Paleolithic—the earliest period of human prehistory—where a substantial body of research into childhood (e.g., Bahn 2015; Finlay 2015; Fischer 1990; Grimm 2000; Langley 2018, 2020; Nowell 2015a,b, 2016, 2020, 2021; Nowell & White 2010; Riede et al. 2018, 2021; Roveland 2000; Sharpe & Van Gelder 2004, 2006; Shea 2006; Stapert 2007; Van Gelder 2015a,b) contrasts with the near-absence of dedicated studies on adolescence. As an initial attempt to bridge this gulf, we have previously developed a baseline model for adolescence in the European Upper Paleolithic (~45,000–12,000 years ago), highlighting the possible role of teenagers in the origins and spread of Late Pleistocene innovations (Nowell & French 2020). Building on this model, in this paper we use the rich bioarchaeological record of the European Gravettian (~35,000–25,000 years ago) to reconstruct the experience of adolescents in Mid-Upper Paleolithic Europe. Combined with wider archaeological data on human societies during this phase of the European Upper Paleolithic, our analysis indicates that while there are some notable

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patterns in the lives and deaths of Gravettian teens, for the most part, the burial data expressed social cohesion rather than social distinctions between age classes.

## 2. Background

### 2.1. Adolescence in the Upper Paleolithic: A baseline

The baseline for adolescence in the Upper Paleolithic developed in Nowell and French (2020) encompasses both the biological and social elements of this life stage, and is based on two central premises: 1) that the key developmental and biological features that define and characterize adolescence in recent human populations also applied to Upper Paleolithic *Homo sapiens* populations, following a general principle of uniformitarianism (Howell 1976; French & Chamberlain 2021); 2) that the best recent analogues for the experience and social perception of adolescence in the Upper Paleolithic, and for the roles and responsibilities of adolescents, are extant hunter-gatherer groups. The main features of this baseline are summarized below.

Biologically, adolescence is defined as the period from the onset of the adolescent growth spurt to its cessation (Bogin 2003, 2009), which (in 20th- 21st century Western contexts) occurs between the ages of ~ 10 and 24 years (Sawyer et al. 2018). During the adolescent growth spurt, individuals gain 50% of their weight and 20% of their final adult stature and experience puberty (sexual maturation)— becoming fertile and developing secondary sexual characteristics (e.g., pubic and other body hair) (Lancaster 1986). Other developmental and biological changes that occur during puberty include a characteristic shift in sleep patterns (prompted by alterations to circadian and homeostatic systems that lead to increasingly later releases of melatonin; Galván 2020; Roenneberg et al. 2004), and changes to the brain within an overall process of maturation (a decrease of cortical grey matter combined with an increase in white matter; Khundrakpam et al. 2016; O'Rourke et al. 2020), including further development of the prefrontal cortex (the area governing executive functions such as attention, inhibition and cognitive flexibility; Burnett & Blakemore 2009) and activation of the amygdala leading to an increasing ability to take on other emotional perspectives (O'Rourke et al. 2020).

Adolescence is universally recognized as a distinct social, as well as biological, stage of development. It is a time when teenagers are prepared for their future economic and family roles and responsibilities (which vary between the sexes) and, during which, in recognition of having reached a new life stage, they are treated differently from both younger children and adults (Schlegel & Barry 1991: 33-35). While the principle of uniformitarianism allows us to extrapolate the biological characteristics of adolescence to the Upper Paleolithic, no equivalent principle exists for social adolescence. Furthermore, social definitions of the length and duration of adolescence are both more variable than those based on biological markers, and in turn, may actually influence the timing and duration of biological adolescence. For example, social and environmental factors such as degree of physical activity, access to nutritious food, life expectancy, and familial and socioeconomic stress have been shown to impact the onset and duration of puberty (Halcrow & Tayles 2008; Nabi et al. 2014; Lewis et al. 2016), and social investment theory suggests that adolescents transition to adulthood and mature more quickly in cultures where they assume adult responsibilities at an earlier age (Bleidorn et al. 2013 and references therein).

Recent hunter-gatherers are not direct and unproblematic analogues for Paleolithic hunter-gatherers (Wobst 1978; Gould 1980) but do represent the best recent analogues for the experience and social perception(s) of adolescence, and for the roles and responsibilities of adolescents in the European Upper Paleolithic. The key features of social adolescence among recent hunter-gatherers are summarized in Table 1 and include high sexual freedom, individual mobility and autonomy, and a lack of an adolescent identity crisis or “teenage rebellion” (the

**Table 1**

Key characteristics of adolescence among hunter-gatherers (after Hewlett & Hewlett 2012). These are the characteristics that are considered unique (or near unique) to foragers and are additional to characteristics of adolescence shared with other higher primates generally (e.g., an increase in sexual activity, an increase in time spent learning complex skills) and humans specifically (e.g., sexual division of labor, marriage).

Characteristics of hunter-gatherer adolescence
Relatively high sexual freedom
Long distance exploration
Autonomy and self-directed social learning
Minimal and non-obligatory responsibility for subsistence and infant care
Physical and emotional intimacy with parents and other adults
Female initiation ceremonies
Lack of adolescent identity crisis
High levels of cultural energy, creativity, and play

latter being a key stereotype of recent Western adolescence; see for example, Blakemore 2018). As argued in Nowell and French (2020), we consider these features to be an appropriate baseline for adolescence among Upper Paleolithic hunter-gatherers, with variability in adolescent behaviors and roles resulting from different foraging adaptations being of a degree rather than of a kind. The relationship between demography and the key characteristics of forager adolescence provides the main support for this assertion. Many of the characteristics listed in Table 1 are driven by the demographic features of hunter-gatherers, including small group sizes, low population densities, and high overall mortality rates (Hewlett & Hewlett 2012). These features are shared by recent and Upper Paleolithic foragers (e.g., Bocquet-Appel et al. 2005; French 2015, 2021; Kretschmer 2015; Maier & Zimmerman 2017; Schmidt and Zimmermann, 2019). For both present-day teenagers, and those of the Upper Paleolithic, adolescence is therefore marked by intensive biological, cognitive, and social changes that have prompted psychologists to describe it as a time of increased creativity, flexibility, exploration, and risk taking (Barbot & Heuser 2017).

Data from recent hunter-gatherers also provide some insight into how the biological and social elements of adolescence influence each other within the foraging adaptation. The age of onset of female adolescence has received particular attention, with the average age of menarche for hunter-gatherer girls being several years later than for girls in the industrialized USA in the 20th/21st century (16.1 years vs. 12.1 years respectively) but with a lower average age of first birth and, consequently, a shorter interval between onset of menarche and first child (average age at first births: 19.5 years vs 26 years, with intervals between the two events of 3.4 years vs. 13.5 years; Jones & Lopez 2006:47). The link between early onset of menarche and increased energy balance and nutrition (as recorded in industrialized countries over the last 100 years; Garn 1987) likely explains the later average age of menarche among foragers. Adolescent subfecundity— the period of up to several years of irregular/anovulatory cycles that follows the onset of menstruation (which may be compounded by low calorie intake)— is likely also responsible for the length of the interval between menarche and first birth among hunter-gatherers (Hochberg & Konner 2020:7). In contrast, age at marriage is a more important factor in determining age at first birth in present-day industrial populations (*ibid.*).

The timing of these key biological events can directly influence the definition and duration of ‘social adolescence’ among foragers. For example, among the Ju/’hoansi (!Kung) the adolescent life stage for women is defined as the period between the onset of menarche and the birth of the first child; following these criteria, ‘adolescents’ are therefore those between approximately 16 and 21 years of age (Howell 2010). For Ju/’hoansi !Kung men the period of adolescence is longer, lasting on average from the ages of 16 to 27, and similarly ending with the birth of the first child (*ibid.*). If the end of adolescence was defined in similar ways in prehistoric hunter-gatherer societies (i.e., by the age at first

birth) then it is likely that, for Upper Paleolithic girls/women, adolescence similarly lasted until the late teens/early twenties, given the combined role of biology and the wider foraging adaptation in determining this variable. Adolescence may have lasted even longer for men (Bogin 2003).

The primary advantage of this baseline model for adolescence in the Upper Paleolithic is that it allows us to consider the role and experience of adolescents in Late Pleistocene societies even in the absence of direct data on these individuals. Much like women, children, and other social groups that are frequently neglected in reconstructions of prehistoric societies (e.g., Conkey & Gero 1997; Kamp 2001), there is no need to demand ‘proof’ of teenagers in the Upper Paleolithic to include them in our interpretations—they were obviously present. Nonetheless, where available, direct data in the form of bioarchaeological (burial) evidence provides crucial additional—and specific—insights into teenage life in the Upper Paleolithic to build upon the general perspectives provided by our baseline.

## 2.2. Adolescence in the European Mid-Upper Paleolithic (Gravettian)

The ‘Gravettian’ refers to the stage within the European Upper Paleolithic chrono-cultural sequence that covers the period from ~35,000–25,000 years ago, spanning the latter part of the cold-temperate Marine Isotope Stage [MIS] 3 and the beginning of the MIS2 glacial (marked by the onset of the Last Glacial Maximum [LGM] from ~27,500 years ago; Clark et al. 2009). Formally defined by the presence of assemblages that include the systematic production of backed lithic artifacts (Gravette points, microgravettes, shouldered points; Reynolds et al. 2017), a broader definition of ‘Gravettian’—which we adhere to here—acts as a synonym for ‘Mid-Upper Paleolithic [MUP]’ with sites and assemblages described as ‘Gravettian’ based on their dating to this interval and/or the presence of other key features, including a diversity of portable female figurines (Nowell and Chang 2014), elaborate ceramic technology (Farbstein and Davies 2015, 2017; Vindiver, 2022), multiple burials with accompanying grave goods, and a limited organic toolkit (e.g., Borgia 2017; de la Peña & Toscano 2013). Following this definition, the Gravettian is a pan-European phenomenon, albeit one that displays clear chronological and geographical variations (regionalization) throughout its tenure (Pesesse 2017). The Gravettian is often characterized as the “golden age” of the European Upper Paleolithic (Roebroeks et al. 2000)—a time when hunter-gatherers across the continent were integrated into an open system (Gamble 1986) of robust and extensive social networks, and participated in European-wide shared cultural traditions, as environmental conditions deteriorated with the approach of the LGM (e.g., Borgia 2017; Formicola & Holt 2015; Holt 2003: 211; Maier & Zimmerman 2017:584; Mussi et al. 2000; Ronchitelli et al. 2015; Trinkaus & Svoboda 2006:461).

## 3. Materials and methods

### 3.1. The Gravettian adolescent bioarchaeological database

The Gravettian provides the richest bioarchaeological database for any sub-stage of the European Upper Paleolithic, both in terms of the number of burials (our focus here) and in the abundance and quality of the accompanying burial data (although the exact number depends on the definition used, and whether isolated remains or just articulated elements are included; compare, e.g., Formicola 2007; Pettitt 2011; Riel-Salvatore & Gravel-Miguel 2013; d’Errico & Vanhaeren 2015). Of those burials dated to the interval ~35,000–25,000 years ago, we consider ~33 to be ‘adolescents’ based on published estimates of age-at-death (derived from multiple measures including dental development, epiphyseal fusion and/or size). To the best of our knowledge, no Upper Paleolithic burials have been identified as ‘adolescents’ based on other skeletal markers for either pubertal stage or onset of menarche as described by Lewis and colleagues (2016; Shapland & Lewis 2013,

2014).

Following the discussion above on the definition of ‘adolescent’ (both in the biological and social sense) among recent foragers and the evidence for a late end to this life stage, we have adopted a broad definition of adolescence here, including in our database all published burials with estimated ages of death between ~10 years and mid-20’s (because of the imprecision in age-at-death assignment for some individuals, our ‘adolescent’ class extends to a maximum of 29 years old at death) (Table 2). Our study therefore includes as ‘adolescents’ some individuals that are classed as ‘children’ or ‘adults’ elsewhere in the literature. We have included those remains that indicate a primary deposition and are in general anatomical position. We have excluded isolated skeletal elements and/or very partial or fragmentary remains except in instances where there is accompanying material culture or their status as a burial is otherwise strongly supported in the literature. The key features of this adolescent database are as follows.

## 4. Results

### 4.1. Demographics (age and sex)

#### 4.1.1. Age

Thirty-three Gravettian burials correspond to our definition of adolescents. We further divide these into young adolescents (those between the ages of ~9 and 13 at death), mid-adolescents (~14–18 years old at death), and older adolescents (~19–late 20’s at death)<sup>2</sup>; categories broad enough to accommodate the uncertainties quoted in published age-at-death estimates, while allowing for variation within our broad definition of ‘adolescent’ to be explored. These categories of young, mid, and older adolescents are represented respectively by 8, 7, and 18 individuals within our database (Table 3).

#### 4.1.2. Sex<sup>3</sup>

Eleven of the individuals in our database were sexed as female/possibly female, and 16 as male/possibly male. No sex assignment was reported for 6 individuals (for details of how these individuals were sexed see Table S1 (Supplementary Material)). This unsexed group consists of those more fragmentary burials for whom the relevant osteological indicators were not present (e.g., Cussac L3A (France) and several of the adolescents from Predmostí (Czech Republic)) or those included in our ‘young adolescent’ category whose estimated age at death is too young to reliably assess sex on morphological grounds (e.g., Kostenki 18 (Russia)).

When age and sex are considered together an interesting pattern emerges. While most teens of both sexes died in late adolescence, males were more evenly distributed with 20% of males dying between the ages of 9 and 13, 30% between roughly 14 and 18 years of age and 50% between 19 and late 20’s. By contrast, all except 2 females in our sample died in late adolescence (81%). Pfeiffer and colleagues (2014) noted a similar pattern in their study of 246 skeletons of Later Stone Age (LSA) foragers of the South African Cape. They found that there were almost twice as many females as males (26 to 14 respectively) in their subsample of 40 late adolescents/very young adults. There was no evidence of difference in levels of interpersonal violence, access to resources, or burial practices in this dataset that could explain the observed sex bias in mortality among this age group. For this reason, Pfeiffer et al. (2014)

<sup>2</sup> See Lewis 2007 and Nowell 2021 for a discussion of ageing subadults in archaeological contexts.

<sup>3</sup> We recognize that biological sex is fluid and cannot be described accurately solely in binary terms. We further acknowledge that in the Paleolithic, binary categories of sex likely did not map neatly onto modern, Western gender constructs. Nonetheless, we are able to identify males and females in the fossil record with some confidence and while these categories are not a perfect proxy for gender classes, they do provide a starting point for analysis.

**Table 2**

Database of Mid-Upper Paleolithic/Gravettian adolescent burials. See accompanying text for discussion as to how 'adolescent' was defined in this context. Unless otherwise specified, all individuals are primary burial depositions.

Individual	Country	Site type	Burial context	Age estimate (years at death)	Young/Mid/Older adolescent	Sex (Male (M)/Female (F))	Body position	Burial orientation	Ochre body treatment	Grave goods-artifacts	Grave goods-associated animal or human remains	Pathologies/abnormalities	Basis of attribution to MUP	Associated <sup>14</sup> C dates (uncal BP)/estimated absolute date	References
Arene Candide I ("Il Principe")	Italy	Cave, Occupation site	Single burial	12–18	M	M	Extended, supine	S-N	Body positioned on a layer of red ochre. Yellow ochre mass between left clavicle and mandible. Red ochre spread over skeleton	Head surrounded by 100's of perforated shells and canines of deer (shell cap). Shells ( <i>Ciprea</i> sp.), 4 pendants of mammoth ivory, 4 perforated "Bâtons de Commandement" of elk antler (3 decorated with thin radial striations around hole), and 23 cm long flint blade held in right hand	N/A	Loss of left mandibular ramus and part of left clavicle to trauma		23 440 ± 190 (OxA-10700)	<a href="#">Giacobini 2007</a> ; <a href="#">Henry-Gambier 2008b</a> ; <a href="#">Pettitt et al. 2003</a>
Baouso da Torre 2 / Balzo della Torre 2/ Bausu da Ture 2 (BT2)	Italy	Cave, Occupation site	Single burial	20–29	O	M	Extended, Left side	NW-SE	None-only ochred artifacts	Ornaments: perforated marine shells and deer canines placed around head, neck, arms, and legs, ochred pebble and blade	N/A	Metacarpal growths	<sup>14</sup> C dating		<a href="#">Formicola &amp; Holt 2015</a> ; <a href="#">Gazzoni &amp; Fontana 2011</a> ; <a href="#">Giacobini 2006</a> ; <a href="#">Villotte et al. 2011</a>
Baouso da Torre 3 / Balzo della Torre 3/ Bausu da Ture 3 (BT3)			Single burial	10–18	M	M?	Extended, prone	NW-SE	N/A	N/A	N/A	Fibula anomaly	Archaeological context; stratigraphy	N/A	<a href="#">Formicola &amp; Holt 2015</a> ; <a href="#">Giacobini 2007</a> ; <a href="#">Villotte et al. 2011, 2017</a> ; <a href="#">Villotte 2018</a>
Barma Grande 3 (BG 3)	Italy	Cave, Occupation site	Multiple burial (with BG 2 & BG 4)	12–13	Y	F?	Extended, Left side	E-W	Buried on an ochre bed. Bodies covered with red ochre and powdered oligist (Hematite/Iron ore)	Ornaments, including collars made of marine shells, fish vertebrae, and deer teeth, bone and ivory pendants with parallel incisions. Lithics (blade, endscraper)	N/A	Groove on frontal squama		14 990 ± 80 (Beta-6 3510/CMAS-7641)	<a href="#">Formicola 1988</a> ; <a href="#">Formicola &amp; Holt 2015</a> ; <a href="#">Gazzoni &amp; Fontana 2011</a> ; <a href="#">Giacobini 2007</a> ; <a href="#">Henry-Gambier 2008a, b</a> ; <a href="#">Onorotini et al. 2012</a>
Barma Grande 4 (BG 4)			Multiple burial (with BG 2 & BG 3)	14–15	M	F?	Extended, Left side	E-W			N/A	Groove on frontal squama; Occipital osteoma	Archaeological context (similarities in grave goods with MUP burials); stratigraphic position		
Caviglione 1 / Barma del Caviglione 1 / "Dame du Cavillon"	Italy	Cave, Occupation site	Single burial	Young adult	O	F	Semi-Flexed, Left side	S-N	Cranial vault coated with red ochre; Groove filled by powdered oligist on front of face; Oligist powder spread over the skeleton	Cap made of shells and perforated deer canines; awl (cervid radius bone); 2 flint blades; shell 'leg bracelet'	N/A	Fractured radius and humerus	<sup>14</sup> C dating	22 400–26 700 (calibrated)	<a href="#">Chevalier 2019</a> ; <a href="#">Formicola &amp; Holt 2015</a> ; <a href="#">Gazzoni &amp; Fontana 2011</a> ; <a href="#">Giacobini 2007</a>

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Table 2 (continued)

Individual	Country	Site type	Burial context	Age estimate (years at death)	Young/Mid/Older adolescent	Sex (Male (M)/Female (F))	Body position	Burial orientation	Ochre body treatment	Grave goods-artifacts	Grave goods-associated animal or human remains	Pathologies/abnormalities	Basis of attribution to MUP	Associated <sup>14</sup> C dates (uncal BP)/estimated absolute date	References
Cussac L3A	France	Decorated cave	Co-mingled remains of multiple individuals of which at least one is an adolescent; result of varying non-natural deposition processes	Late adolescent	O	?	Partial skeleton; not in anatomical position	?	Some red pigment on bones and/or underlying sediment	N/A (but associated with parietal art in the cave?)	N/A	N/A	<sup>14</sup> C dating	25 120 ± 120 (Beta 156643)	Aujoulat et al. 2002; Formicola 2007; Kacki et al. 2020; Peigneaux et al. 2019
Dolní Věstonice 13	Czech Republic	Open air, Occupation site	Multiple burial	17–19	M	M	Extended, supine	SSE-NNW	Ochre covering on head and upper torso	Ornaments (pierced carnivore teeth and perforated ivory); lithics; bone awl	N/A	N/A		27 040 ± 100 (Aix-12027) (DV13); 26 760 ± 100 (Aix-12028) (DV14); 26 680 ± 70 (Aix-12029) (DV15); 27 660 ± 80 (GrN-13692); 26 640 ± 110 (GrN-14831); 24 000 ± 900 (ISGS-1616); 24970 ± 920 (ISGS-1617) (associated with burial)	Alt et al. 1997; Fewlass et al. 2019; Formicola 2007; Formicola et al. 2001; Hillson et al. 2006; Mitnik et al. 2016; Trinkaus et al. 2001
Dolní Věstonice 14				16–17	M	M	Extended, prone	S-N	Ochre covering on head, upper torso, and pelvic area			Abnormalities on femur, humerus, radius, and ulna; shortened left forearm, possible scoliosis, dental abnormalities, traumatic injuries	<sup>14</sup> C dating		
Dolní Věstonice 15				20	O	M	Extended, supine	S-N	Ochre covering on head and upper torso			Developmental dysplasias on right humerus, left radius and ulna, and femora (Paralysis? Encephalitis? Rickets?)			
Grotta dei Fanciulli 4 (Enfants) (GF 4)*	Italy	Cave, Occupation site	Single burial	?	O	F	Extended	N-S			N/A	Asymmetrical hypertrophy (nerve damage on upper limb?)			Formicola & Holt 2015; Gazzoni & Fontana 2011; Giacobini 2007; Henry-Gambier 2008a,b; Mallegni and Parenti, 1972–1973; Riel-Salvatore & Gravel-Miguel 2013
Grotta dei Fanciulli 5 (Enfants) (GF 5)*			Double burial (with GF 6)	?	O	M	Flexed	N-S		Shells ( <i>Cyclope</i> ), perforated deer canines, and flint tools	N/A	N/A			
Grotta dei Fanciulli 6 (Enfants) (GF 6)*			Double burial (with GF 5)	12–15	M	M	Flexed	N-S			N/A	N/A	Archaeological context; stratigraphy; associated fauna (?)		
Kostenki 18 (Khvoikovskaia)	Russia	Open air, Occupation site	Single burial	9–10	Y	?	Semi-Flexed, Left side	SW-NW	N/A	N/A	3 layers of mammoth bones in artificial arrangements around the burial, including two scapulae fragments placed on the head and torso	N/A	<sup>14</sup> C dating	23 440 ± 150 (OxA-X 2666–53)	Henry-Gambier 2008a, b; Sinityn 2004; Reynolds et al. 2017

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Table 2 (continued)

Individual	Country	Site type	Burial context	Age estimate (years at death)	Young/Mid/Older adolescent	Sex (Male (M)/Female (F))	Body position	Burial orientation	Ochre body treatment	Grave goods-artifacts	Grave goods-associated animal or human remains	Pathologies/abnormalities	Basis of attribution to MUP	Associated <sup>14</sup> C dates (uncal BP)/estimated absolute date	References
Ostuni 1 /Os1	Italy	Cave, Occupation site	Double burial (With Os1b (fetus))	20	O	F	Crouched, left side	S-N	Body positioned on a layer of red ochre	Ornamentation: Perforated shells around wrists and covering head (latter covered in red ochre), as well as near the forearms and torso; Pierced deer canine; lithics; incised fragment of manganese oxide placed near feet	Ungulate teeth and bones	N/A	<sup>14</sup> C dating	23 446 ± 107 (MAMS-11449); 24 410 ± 320 (Gif-9247)	Chakroun et al. 2018; Fu et al. 2016; Giacobini 2007; Nava et al. 2017; Ronchitelli et al. 2015
Paglicci II/12	Italy	Cave, Occupation site	Single burial	10–14	Y	M	Extended, Supine	SW-NE	Ochre cover, thick on head. Fine layer of haematite. Bones and grave goods are ochre soaked. Red pigment most abundant around skull	Tool kit: 11 lithics, 1 bone piercer (unused); Ornaments: 30 red deer craches close to skull, one on left wrist and one near right ankle; 2 specimens of <i>Luria lurida</i> (Cypraeidae) on left hemithorax, and block of manganese oxide between ankles, close to right tibia	N/A	N/A	<sup>14</sup> C dating	24 720 ± 420 (F-55)	Giacobini, 2007; Mussi 2002; Riel-Salvatore & Clark 2001; Ronchitelli et al. 2015; Shackelford et al. 2012
Paglicci III/25			Single burial	18–25	O	F	Extended, supine	N-S	Ochre bed, chunks of ochred stone over grave. Humerus soaked with red ochre. Grave strewn with ochre. Ochre concentrated on head, pelvis and feet; Smudge of ochre covering head and extending toward right side of skull - possibly corresponded to the hair	Tool kit: 5 lithic artifacts (unused); Ornaments: 7 red deer craches on the front, 1 valve of Pecten (scallop) close to left foot; Forehead: 7 deer craches with pierced roots turned towards the face	Ungulate skull fragments (mainly <i>Equus ferus</i> )	N/A	<sup>14</sup> C dating	23 470 ± 370 (F-57); 23 040 ± 380 (F-58)	

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Table 2 (continued)

Individual	Country	Site type	Burial context	Age estimate (years at death)	Young/Mid/Older adolescent (M)/	Sex (Male (M)/Female (F))	Body position	Burial orientation	Ochre body treatment	Grave goods-artifacts	Grave goods-associated animal or human remains	Pathologies/abnormalities	Basis of attribution to MUP	Associated <sup>14</sup> C dates (uncal BP)/estimated absolute date	References
Pataud 1	France	Rock-shelter,	Multiple burial (found in two concentrations at site); likely a combination of primary and secondary deposition. Fragmentary condition attributed to post-depositional disturbances of natural origin and damage during excavation	20–29	O	F	Partial skeleton;	?	Traces	Range of potential grave goods located near burial concentrations including portable art objects, bones tools and ornaments (beads)	Some faunal remains included “extra-ordinary object” (Chiotti et al. 2015) level, including red deer skulls, mammoth tusk, and reindeer antler. Some perforation, incision, and ochre staining on these objects indicates that they should, perhaps, be considered as ‘artifacts’	Supernumerary teeth N/A N/A	<sup>14</sup> C dating	21 800 ± 90 (GrA-45013); 21 910 ± 90 (GrA-45133); 22 360 ± 90 (GrA-45132); 22 470 ± 90 (GrA-45016)	Chiotti et al. 2015; Henry-Gambier et al. 2013; Nespoulet et al. 2006; Villotte et al. 2015b, 2018
Pataud 3	France	Occupation		>20	O	F	not in anatomical position								
Pataud 5	France	site		>20	O	M?									
Paviland 1 (“Red Lady”)	UK	Cave, Occupation site	Single burial	20–29	O	M	Extended, supine	NE-SW	Ochre staining visible over skeleton; scattered over bones or absorbed from clothing?	Ornamentation: ivory rods, periwinkle shells, ivory rings, and perforated shells (remnants of possible clothing)	Associated mammoth skull and other large mammal bones	N/A	<sup>14</sup> C dating	28 870 ± 180 (OxA-16412); 28 400 ± 320 (OxA-16502); 29 490 ± 210 (OxA-16413); 28 820 ± 340 (OxA-16503); 25 850 ± 280 (OxA-8025); 26 350 ± 550 (OxA-1815)	Aldhouse-Green & Pettitt 1998; Henry-Gambier 2008b; Jacobi & Higham 2008
Předmostí 1	Czech Republic	Open air, Occupation site	Multiple burial pit (see text for further discussion of context)	20–25	O	F	Partial skeleton;	?	N/A	N/A	Large number of mammoth and other animal bones, including a fox skull placed in close association with one individual, two mammoth shoulder blades covering the individuals placed at the north-eastern and south-western ends of the feature, and wolf skeletons nearby		<sup>14</sup> C dating	25 820 ± 170 (GrN-1286)	Klima 1991; Svoboda 2008; Ullrich 1996; Zilhão & Trinkaus 2002
Předmostí 5				12–16	O	F	not in anatomical position								
Předmostí 7				12–14	M	?									
Předmostí 9				20–25	O	M									
Předmostí 10				20–25	O	F									
Předmostí 18				20	O	M									
Předmostí 20				9–10	Y	?									
Předmostí 22	9–11	Y	?												
Předmostí 25	<12	Y	?												

(continued on next page)

Table 2 (continued)

Individual	Country	Site type	Burial context	Age estimate (years at death)	Young/Mid/Older adolescent	Sex (Male (M)/Female (F))	Body position	Burial orientation	Ochre body treatment	Grave goods-artifacts	Grave goods-associated animal or human remains	Pathologies/abnormalities	Basis of attribution to MUP	Associated <sup>14</sup> C dates (uncal BP)/estimated absolute date	References
Sunghir 2	Russia	Open air, Occupation site	Double burial	12–13	Y	M	Extended, supine	SW-NE	Ochre covering, principally of head, trunk, and upper arms. Accompanying isolated element (Sunghir 4) filled with ochre	>13,000 mammoth ivory beads. Mobiliary art objects, hundreds of perforated arctic fox canines, ivory spears, ivory pins, disc-shaped pendants, ivory animal carvings, long spears of mammoth tusk	Human remains- Isolated element (femoral diaphysis of an adult) designated Sunghir 4	Unusual development of face, dentition, humerus and femur		23 830 ± 220 (OxA-9037); 27 210 ± 710 (AA-36474); 26 200 ± 640 (AA-36475); <b>30,100 ± 550 (OxX-2395-6)</b> ; 25 020 ± 120 (OxA-15753)	<a href="#">Dobrovolskaya et al. 2012</a> ; <a href="#">Formicola &amp; Buzhilova 2004</a> ; <a href="#">Nalawade-Chavan et al. 2014</a> ; <a href="#">Sikora et al. 2017</a> ; <a href="#">Trinkaus &amp; Buzhilova 2018</a> ; <a href="#">Trinkaus et al. 2014</a>
Sunghir 3				9–10	Y	M	Extended, supine	NE-SW				Abnormal femora (congenital bowing)	<sup>14</sup> C dating	24 100 ± 240 (OxA-9038); 26 190 ± 640 (AA-36476); <b>30,000 ± 550 (OxX-2395-7)</b> ; 25 430 ± 160 (OxA-15751); 24 830 ± 110 (OxA-15754); 26 000 ± 410 (KIA-27007)	
Vilhonheur 1	France	Decorated cave	Single burial	“Later teens or early twenties”	O	M	Partial skeleton; not in anatomical position	?	N/A	N/A	N/A	N/A	<sup>14</sup> C dating	27 010 ± 210 (Beta 216141); 26 690 ± 190 (Beta 216142)	<a href="#">Henry-Gambier et al. 2007</a>

Key: Young adolescent (~9 and 13 years old at death), mid adolescent (~14–18 years old at death), older adolescent (~19-late 20's at death). In most cases listed <sup>14</sup>C dates are dates associated with the site and/or relevant archaeological level. Dates in bold indicate direct <sup>14</sup>C dates on the burial. Dates in italics are considered unreliable or inconsistent with context. M? and F? indicate a fossil that has been sexed as “likely male” and “likely female”, respectively. “?” indicates that sex could not be determined.

Note: \* The data on these burials available from the literature is frequently contradictory with regard to their age, sex, and orientation (e.g., compare [Mussi 2002](#) vs. [Pettitt 2011](#) vs. [Giacobini 2007](#)).

concluded that risks associated with a woman's first pregnancy best explained why more young women were dying, making first pregnancy a significant life history factor, because "compared to subsequent births, first time childbirth is a risky undertaking, prone to complication by cephalopelvic disproportion, fetal presentation, and potentially by other complications" (Pfeiffer et al. 2014:16).

## 4.2. Mortuary practices

### 4.2.1. Type of burial

**4.2.1.1. Location.** Of the 33 adolescent burials presented in Table 2, 15 were uncovered in caves (including 2 in decorated caves) with a further 3 burials located in rock shelters. Fifteen teens were buried in open-air sites with nearly two-thirds of the open-air interments accounted for by the mass burial pit at Předmostí.

**4.2.1.2. Single vs double/ multiple.** While approximately one third of teens in our sample ( $n = 10$ ) were buried on their own, most (66%) adolescents were buried in the company of others including adults, children, and infants. This majority pattern holds true when burial types are considered by sex and adolescent age category. The multiple interments include double burials at Grotte des Enfants (Italy) and Sungir (Russia)<sup>4</sup> (see below), triple burials at Barma Grande (Italy), Dolní Věstonice (Czech Republic) and Abri Pataud (France) and the mass burial at Předmostí. While all but one of the single burials were uncovered in caves, 60% of the multiple inhumations were located in open-air locales. Male adolescent interments were fairly evenly split between open-air sites and caves or rock shelters. By contrast, female adolescents were far more likely to be buried in caves or rock shelters with 72% of them recovered from this type of site.

### 4.2.2. Treatment of the body

**4.2.2.1. Position/orientation.** Information on body position and orientation is not included for all the burials in our sample. Of the 19 burials where position was reported, 14 adolescents were laid out in an extended position with 8 supine (lying on their backs), 2 prone (lying on their fronts), 3 on their left side and none on their right; one of the extended burials did not have more specific information on position associated with it. Five inhumations were semi-flexed, flexed or in a crouching position. There is no discernible pattern in positioning based on age, sex, or geographic location. Eight of the 19 burials for which we have orientation data were laid out north to south including 3 of the 4 older adolescent females. No other patterns in the arrangement of the dead were detected.

**4.2.2.2. Ochre and coverings.** Gravettian communities commonly buried adolescents with ochre (58% of burials in our sample). While the burial pit at Předmostí is largely sterile, 20 of the remaining 24 burials for which we have data contained either ochre or artifacts and 19 of them contained both. Red ochre appears to have been the pigment of choice with yellow ochre only present in the burial of Arene Candide 1 ('Il Principe') (Italy). In this richly adorned interment, yellow ochre was used to "fill in" a missing portion of the left mandibular ramus (Pettitt et al. 2003). In a few cases, ochre was used as a foundational layer or 'bed' upon which to lay the teen to rest. Most often, ochre covered an individual's head, face, and upper torso and, more rarely, the pelvis and

<sup>4</sup> <sup>4</sup> The burials from Sungir fit within our broad definition of 'Gravettian' as given above but would not be considered 'Gravettian' *sensu stricto* (i.e., associated with Gravettian lithics) (Reynolds et al. 2017). The direct <sup>14</sup>C dates (Marom et al. 2012; Nalawade-Chavan et al. 2014; see Table 2 and 4, this article) for the burials furthermore indicate that chronologically they are best described as Early/Mid-Upper Paleolithic in age.

**Table 3**

Demographic summary (age and sex) of the individuals within the Mid-Upper Paleolithic adolescent database.

	Young adolescent (~9–13 years old at death)	Mid-adolescent (~14–18 years old at death)	Older adolescent (~19-late 20's years old at death)	Total
Male	3	5	8	16
Female	1	1	9	11
Unsexed	4	1	1	6
Total	8	7	18	33

limbs. The amount of pigment used varied from a 'sprinkling' to descriptions of bones being 'soaked' in ochre (e.g., the younger male adolescent Paglicci 2/12 (Italy); Ronchitelli et al. 2015). In most cases, it is not clear whether the ochre was applied directly to the teens' bodies or to any (now deteriorated) clothing. In cases where the ochre is limited to one part of the body such as the head and face, it is possible that we are seeing the outline of an organic hat, mask, or other type of covering that has long since disintegrated. The likelihood of Gravettian adolescents being buried with some form of clothing or covering is further supported by the burials of Arene Candide 1/ 'Il Principe' and Caviglione 1 (Italy) where the arrangement of shells around the heads suggests they were once part of a cap (Pettitt et al. 2003; Gazzoni & Fontana 2011).

### 4.2.3. Grave goods

**4.2.3.1. Artifacts.** Most of the adolescents in our database were buried with some artifactual grave goods (58%,  $n = 19$ ). Of the 13 adolescents buried without grave goods, the majority ( $n = 9$ ) derive from the Předmostí multiple burial. In all cases when adolescents were buried without artifactual grave goods, they were also buried without ochre or other similar treatments. Grave goods were found in male and female burials and with adolescents of all ages but were most common among older adolescents. Artifacts buried with adolescents in the MUP varied, but typically included organic and lithic tools and ornaments (perforated shells, ivory, and teeth, fashioned into beads, which, as described above, might have decorated clothing). Other items of personal adornment included pendants, necklaces and "collars", and wrist and ankle bracelets.

**4.2.3.2. Other animal and human remains.** In addition to the artifactual grave goods described above, 5 adolescents within our sample—as well as those adolescents included in the Předmostí burial—were buried with accompanying faunal remains (distinguished from the organic items described above by their lack of clear human modification). Three of these belonged to our 'older adolescent' category (Dolní Věstonice 15, Ostuni 1 (Italy), and the 'Red Lady' of Paviland (UK)), although the most striking example of this practice in our database is that of the young adolescent from Kostenki 18, who was buried surrounded by three layers of mammoth bones in varying formations (Reynolds et al. 2017). Dolní Věstonice 15 represents another intriguing case, as he was buried with a fragment of burnt reindeer pelvis in his mouth. Given this teen's chronic and traumatic afflictions (see below), Bahn (2011: 346) has argued that the bone may have served as a "a clamp to bite on during times of great pain, as it shows traces of scratches and pressure".

The aforementioned double burial of Sungir 2 and 3 is unique among our database of MUP adolescents in that these individuals were buried with an isolated element of another human; Sungir 4—an adult represented by a single femoral diaphysis which was filled with red ochre and placed alongside the left arm of Sungir 2. In addition to the ochre fill, the femur shows other signs of intentional modification such as polishing prior to burial. Chemical analysis of the Sungir 4 femur further indicates both that the post-mortem history of this element differed from that of the more complete Sungir 2 and 3 remains, and

**Table 4**  
**Database of Mid-Upper Paleolithic/Gravettian burials (excluding the adolescents given in Table 2). Age categories: Infant- one year old or younger at death; Child – 1–9 years old at death; adult-29 years or older at death. Unless otherwise specified, all individuals are primary burial depositions.** In most cases listed <sup>14</sup>C dates are dates associated with the site and/or relevant archaeological level. Dates in bold indicate direct <sup>14</sup>C dates on the burial. Dates in italics are considered unreliable or inconsistent with context. M? and F? indicate a fossil that has been sexed as “likely male” and “likely female”, respectively. “?” indicates that sex could not be determined.

Individual	Country	Site type	Burial context	Age estimate (years at death)	Age class (Infant/ Child/ Adult)	Sex (Male (M)/ Female (F))	Body position	Burial orientation	Ochre body treatment	Grave goods-artifacts	Grave goods-associated animal or human remains (details)	Pathologies/ abnormalities	Basis of attribution to MUP	Associated <sup>14</sup> C dates (uncal BP)/ estimated absolute date	References
Cro-Magnon 1 (Alpha)	France	Rock-shelter, occupation site	Multiple burial (possible funerary caching; see Pettitt 2011); remains commingled following early excavation in 19th century	Older adult	Adult	M	Not in anatomical position	?	Some ochre covering on concreted bones	~300 ochre-stained shells, flint blade, ivory, and shell pendants /ornaments	N/A	Histiocytosis X	<sup>14</sup> C dating	27 680 ± 270 (Beta-157439)	Henry-Gambier et al. 2013; Pettitt 2011:152; Thibeault & Villotte 2018; Villotte et al. 2020
Cro-Magnon 2 (Beta)				Older adult	Adult	F		?							
Cro-Magnon 3 (Gamma)				Older adult	Adult	M		?							
Cro-Magnon 4 (Delta)				Older adult	Adult	M?		?				N/A			
Cro-Magnon 5-1				<1	Infant	?		?							Partiot et al. 2020
Cro-Magnon 5-2				<1	Infant	?		?							
Cro-Magnon 5-3				<1	Infant	?		?							
Cro-Magnon 5-4				<1	Infant	?		?							
Cussac L2A	France	Decorated cave	Single burial	20–50	Adult	M	Prone	S-N	N/A	N/A	N/A	Notably small stature unusual cranial shape	<sup>14</sup> C dating	25 120 ± 120 (Beta 156643)	Guyomarc'h et al. 2017; Kacki et al. 2020; Villotte et al. 2015a
Pataud 2	France	Rock-shelter, occupation site	Multiple burial (found in two concentrations at site); likely a combination of primary and secondary deposition. Fragmentary condition attributed to post-depositional disturbances of natural origin and damage during excavation	<1	Infant	?	Partial skeleton; not in anatomical position	?	Traces	Range of potential grave goods located near burial concentrations including portable art objects, bones tools and ornaments (beads)	Some faunal remains included in associated “extra-ordinary object” (Chiotti et al. 2015) level, including red deer skulls, mammoth tusk, and reindeer antler. Some perforation, incision, and ochre staining on these objects indicates that they should, perhaps, be considered as ‘artifacts’	N/A	<sup>14</sup> C dating	21 800 ± 90 (GrA-45013); 21 910 ± 90 (GrA-45133); 22 360 ± 90 (GrA-45132); 22 470 ± 90 (GrA-45016)	Chiotti et al. 2015; Henry-Gambier et al. 2013; Nespoulet et al. 2006; Villotte et al. 2015b, 2018
Pataud 4				<1	Infant	?	Partial skeleton; not in anatomical position	?				N/A			
Pataud 6				4–7	Child	?	Partial skeleton; not in anatomical position	?				Inverted premolar			

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Table 4 (continued)

Individual	Country	Site type	Burial context	Age estimate (years at death)	Age class (Infant/Child/Adult)	Sex (Male (M)/Female (F))	Body position	Burial orientation	Ochre body treatment	Grave goods-artifacts	Grave goods-associated animal or human remains (details)	Pathologies/abnormalities	Basis of attribution to MUP	Associated <sup>14</sup> C dates (uncal BP)/estimated absolute date	References
Lagar Velho 1	Portugal	Cave	Single burial	4–5	Child	?	Supine	E-W	Body heavily ochre stained, as is the containing sediment (distribution suggests a wrap around the body)	Ornaments: Perforated shell and animal teeth (red deer)	Multiple faunal assemblages possibly associated with the burial (above, in, and below the grave fill/cut). Those in the grave fill are clearly associated with the burial and include those of a rabbit (placed on the child's legs) and two red deer pelvises (one placed by the child's shoulder, one by its feet)	Minor traumatic injury to left radius; 'hyper-arctic' body proportions	<sup>14</sup> C dating	24 860 ± 200 (GrA-13310); 24 660 ± 260 (OxA-8421); 23 920 ± 220 (OxA-8422); 24 520 ± 240 (OxA-8423)	Duarte et al. 1999; Zilhao & Trinkaus 2002
Brno II	Czech Republic	Open-air	Single burial; disturbed by natural causes post-deposition and by early excavations	'Middle Aged'	Adult	M	Not in anatomical position	?	Covering of body	Shells, reindeer antler rod, roundels (stone, bone, and ivory), marionette (ivory-male figure)	Ribs (rhino), mammoth scapula near skull; possible association with large pile of bones found nearby (rhino, mammoth)	Periostitis; cranial trauma	<sup>14</sup> C dating	23 680 ± 200 (OxA-8293)	Pettitt & Trinkaus 2000; Oliva & Riel-Salvatore & Clark 2001
Brno III			Single burial	?	Adult	F	Right-side, strongly flexed	?	Covering of body	N/A	N/A	N/A	Archaeological context; N/A stratigraphy (?)		
Pavlov I	Czech Republic	Open-air, occupation site	Single burial	36–45	Adult	M	Right-side, flexed	S-N	N/A	N/A	Body covered by two mammoth scapulae, a long bone, and a molar; isolated remains of two other people (Pavlov 2, 3, 4) found adjacent to the burial	Neurocranial trauma	<sup>14</sup> C dating	25 490 ± 90 (Aix-12026); 26 170 ± 450 (GrN-20391)	Fewlass et al. 2019; Hillson et al. 2006; Svoboda 2006

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Table 4 (continued)

Individual	Country	Site type	Burial context	Age estimate (years at death)	Age class (Infant/Child/Adult)	Sex (Male (M)/Female (F))	Body position	Burial orientation	Ochre body treatment	Grave goods-artifacts	Grave goods-associated animal or human remains (details)	Pathologies/abnormalities	Basis of attribution to MUP	Associated <sup>14</sup> C dates (uncal BP)/estimated absolute date	References
Dolní Věstonice 3 (DV I)	Czech Republic	Open-air, occupation site	Single burial	36–45	Adult	F	Right-side, strongly flexed	NW-SE	On skull	Ornaments (incised fox canines); flint blades	Mammoth scapulae covering burial; large mammoth bone (pelvis) found nearby interpreted as associated with the burial; fox pelvis and phalanges	Cranial trauma; loss of left mandibular condyle, subchondral pits in articular regions	<sup>14</sup> C dating	25 870 ± 220 (OxA-36176); 25 950 + 630/-580 (GrN-18189)	Fewlass et al. 2019; Hillson et al. 2006; Nerudová et al. 2019; Svoboda 2006; Trinkaus 2018
Dolní Věstonice 4 (DV I)			Single burial	4–12	Child	?	Partial skeleton; not in anatomical position	?	On skull	Fox canines (necklace or headdress?)	Burial (represented by cranial fragments) placed under an incomplete mammoth scapula	N/A	Archaeological context; stratigraphy	N/A	
Dolní Věstonice 16 (DV II)			Single burial	40 +	Adult	M	Right-side, flexed	E-W	On skull, chest and pelvis	Ornaments (pierced canines); possible nearby lithics associated with burial	N/A	Scoliosis, deformed femur, osteoarthritis, cranial fracture, and resultant facial asymmetry (cleft palate?)	<sup>14</sup> C dating	27 220 ± 110 (Aix-12030); 26 390 ± 270 (ISGS-1744); 25 570 ± 280 (GrN-15276); 25 740 ± 210 (GrN-15277)	
Předmostí 2 Předmostí 3 Předmostí 4 Předmostí 6 Předmostí 8 Předmostí 11 Předmostí 12 Předmostí 13 Předmostí 14 Předmostí 15 Předmostí 16 Předmostí 17	Czech Republic	Open-air, occupation site	Multiple burial pit (see text for further discussion of context)	6–7 35–40 30–35 2–3 3–4 0–3 0–3 0–3 35+ 4–12 4–12 4–12	Child Adult Adult Infant Child Infant Infant Adult Adult Child Child Child	? M F ? ? ? ? ? ? ? ? ?	Partial skeleton; not in anatomical position	?	N/A	N/A	Large number of mammoth and other animal bones, including a fox skull placed in close association with one individual, two mammoth shoulder blades covering the individuals placed at the north-eastern and south-western ends of the feature, and wolf skeletons nearby	N/A	<sup>14</sup> C dating	25 820 ± 170 (GrN-1286)	Klima 1991; Svoboda 2008; Ullrich 1996; Zilhão & Trinkaus 2002

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Table 4 (continued)

Individual	Country	Site type	Burial context	Age estimate (years at death)	Age class (Infant/Child/Adult)	Sex (Male/M/F)	Body position	Burial orientation	Ochre body treatment	Grave goods-artifacts	Grave goods-associated animal or human remains (details)	Pathologies/abnormalities	Basis of attribution to MUP	Associated <sup>14</sup> C dates (uncal BP)/estimated absolute date	References
Krems-Wachtberg 1a	Austria	Open-air, occupation site	Double burial	<1	Infant	M	Left side, flexed	N-S	Embedded in ochre	Mammoth ivory beads, perforated mollusc shells, and fox incisor	Grave 'sealed' with a mammoth scapula, next to which was a fragment of mammoth tusk (a support for the scapulae?)	N/A	<sup>14</sup> C dating /Thermoluminescence (TL) dating	26 580 ± 160 (Poz-1290); 26 520 + 210/-200 (VERA-3819) 33.9 ± 2.3 ka (mean weighted TL age)	<a href="#">Einwögerer et al. 2006, 2009;</a> <a href="#">Teschler-Nicola et al. 2020;</a> <a href="#">Zöller et al. 2014</a>
Krems-Wachtberg 1b				<1	Infant	M	Left side, flexed	N-S	Embedded in ochre						
Krems-Wachtberg 2			Single burial	<1	Infant	M	Right-side, flexed	S-N	Embedded in ochre (wrapped in ochre-stained shroud)	Mammoth ivory pin	N/A	N/A			
Borsuka Cave	Poland	Cave	Isolated elements (teeth) interpreted as the remains of a disturbed single burial (though no grave pit identified)	<2	Infant	?	Not in anatomical position (teeth only)	?	N/A	100 + pendants made from elk and auroch teeth	N/A	N/A	<sup>14</sup> C dating	27 350 ± 450 (Poz-32394; 26 430 ± 180 (Poz-38237); 25 150 ± 160 (Poz-38236)	<a href="#">Wilczyński et al. 2016</a>
Barma Grande 1 (BG 1)			Single burial	?	Adult	M	Extended	N-S	N/A	Ornaments, blades	N/A	N/A			<a href="#">Churchill &amp; Formicola 1997;</a> <a href="#">Formicola &amp; Holt 2015;</a> <a href="#">Mussi 2002;</a> <a href="#">Trinkaus et al. 2014 (Table 3.1);</a> <a href="#">Trinkaus 2018</a>
Barma Grande 2 (BG 2)	Italy	Cave, occupation site	Multiple burial (with BG 3,4)	30–35	Adult	M	Supine, extended	E-W	Buried on an ochre bed	Ornaments, including collars made of marine shells, fish vertebrae, and deer teeth, bone and ivory pendants with parallel incisions. Lithics (blade, end scraper)	N/A	Upper limb asymmetry; notably large (robust) size	Archaeological context (similarities in grave goods with MUP burials); stratigraphic position	N/A	<a href="#">Formicola et al. 2004</a>
Barma Grande 5 (BG 5)			Single burial	?	Adult	F	Left side, extended	S-N	Found over most of body	Ornamentation (?)	N/A	N/A			
Barma Grande 6 (BG 6)			Single burial	?	Adult	M	Left side, flexed	N-S	N/A	Perforated shells	N/A	N/A	<sup>14</sup> C dating	<b>24 800 ± 800 (OxA-10093)</b>	<a href="#">Formicola et al. 2004</a>
Baouso da Torre 1 / Balzo della Torre 1 / Bausu da Ture (BT 1)	Italy	Cave, occupation site	Single burial	20–49	Adult	M	Supine, extended	NW-SE	Ochre cover?	Flint blade, ornaments (shells and pierced deer teeth)	N/A	Metacarpal growths	Archaeological context; stratigraphy	N/A	<a href="#">Villotte et al. 2011, 2017</a>

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Table 4 (continued)

Individual	Country	Site type	Burial context	Age estimate (years at death)	Age class (Infant/Child/Adult)	Sex (Male (M)/Female (F))	Body position	Burial orientation	Ochre body treatment	Grave goods-artifacts	Grave goods-associated animal or human remains (details)	Pathologies/abnormalities	Basis of attribution to MUP	Associated <sup>14</sup> C dates (uncal BP)/estimated absolute date	References
Ostuni 2	Italy	Cave, occupation site	Single burial	?	Adult	?	Right-side, flexed	S-N	N/A	Ornaments (shells, pierced deer teeth)	N	N/A	<sup>14</sup> C dating	24 910 ± 125 (MAMS-11450)	Fu et al. 2016; Giacobini 2006; Nava et al. 2017
Veneri Parabita 1 Veneri Parabita 2	Italy	Cave	Double burial	30–35 30–35	Adult Adult	M F	Supine, semi-flexed Supine, semi-flexed	S-N S-N	Ochre sprinkles over bodies	Flint fragment sprinkled with ochre, ochred pebble placed on pelvis (Parabita 2), perforated and ochre sprinkled <i>Cervus</i> canines at base of grave (head ornament for Parabita 2?)	N	Ankylosing spondylitis N/A	<sup>14</sup> C dating	22 200 ± 360; 22 110 ± 330	Mallegni et al. 2000; Mussi 2002; Riel-Salvatore & Clark 2001
Kostenki 2	Russia	Open-air, occupation site	Single burial	Older adult “elderly man”	Adult	M	Sitting	?	N	N/A	Body placed in chamber constructed of mammoth bones and tusks	N/A	<sup>14</sup> C dating	23 880 ± 150 (GIN-7992)	Henry-Gambier 2008a, b; SinitSyn 2004; Reynolds et al. 2017
Kostenki 12			Single burial	<1	Infant	?	Supine, Extended	?	N	None discovered during excavation, but body possibly wrapped/covered in skins	N/A	N/A	<sup>14</sup> C dating	23 600 ± 300 (GIN 89); 32 700 ± 700 (GrN 7758); 24 000 ± 800 BP (GIN-8019); 26 300 ± 300 BP (GIN-8574); 28 500 ± 140 (GrA-5552); 28,700 ± 400 BP (LE-1428a); 29 030 ± 560 BP (LU-1821); 30 240 ± 400 BP (LE-1428b); 31 150 ± 150 BP (LE-1428c); 31 900 ± 200 BP (LE-1428d)	
Kostenki 15			Single burial	6–7	Child	?	Sitting	N-S	Red and yellow ochre on base on grave cut	Ornaments (fox canine pendants), needles and flint flakes	Mammoth scapula covering burial pit	N/A	<sup>14</sup> C dating	21 720 ± 570 (LE-1430); 25 700 ± 250 BP (GIN-8020)	
Sunguir 1	Russia	Open-air, occupation site	Single burial	35–45	Adult	M	Supine, extended	NE-SW	Over body, particular concentration over the skull	~3000 mammoth ivory beads, mammoth ivory bracelets, schist pendant	N/A	Unusually long clavicles	<sup>14</sup> C dating	22 930 ± 200 (OxA-9036); 19 160 ± 270 (AA-36473); 28 890 ± 430 (OxA-X-	Nalawade-Chavan et al. 2014; Trinkaus & Buzhilova

(continued on next page)

Table 4 (continued)

Individual	Country	Site type	Burial context	Age estimate (years at death)	Age class (Infant/Child/Adult)	Sex (Male (M)/Female (F))	Body position	Burial orientation	Ochre body treatment	Grave goods-artifacts	Grave goods-associated animal or human remains (details)	Pathologies/abnormalities	Basis of attribution to MUP	Associated <sup>14</sup> C dates (uncal BP)/estimated absolute date	References
Sunghir 5			Possible single burial; assumed to be a formal deposition despite consisting of an isolated element (cranium)	30–50	Adult	?	Isolated element (cranium)	?	Cranium placed on flat stone along with ochre. Post-depositional displacement means that the exact association between the ochre and the cranium is unclear	Ivory bead, fox canine	N/A	N/A	<sup>14</sup> C dating	<b>2464–12</b> (Sunghir 1) (see also refs for site in Table 2)	<a href="#">2012, 2018; Trinkaus et al. 2014</a>
Sunghir 10 (Grave 2bis)			Single burial	?	Adult	?	Supine, extended	?	Body partially covered	Ornaments (schist pendants, mammoth ivory beads, pierced fox canines), awl, biface, worked mollusc shell and mammoth tusk, reindeer antler clubs	N/A	N/A			
Mal'ta 1	Russia	Open-air, occupation site	Double burial	3–4	Child	?	Laying on left side	N-S	Bodies placed on ochre	Necklace of mammoth beads, bird pendant, bracelet, carved rectangular disk, lithics and bone tools	N/A	N/A	<sup>14</sup> C dating	<b>20 240 ± 60</b> (UCIAMS79666)	<a href="#">Alekseev 1998; Derev'anko 1998; Kirrlov &amp; Derev'anko 1998; Lbova 2021; Raghavan et al. 2014; Shackelford et al. 2012; Tompkins 1996</a>
Mal'ta 2				<1	Infant	?	Isolated element (dentition)	N-S				N/A	Archaeological context; stratigraphy; association with Mal'ta 1		

potentially that the individual represented by Sunghir 4 grew up in a different region from Sunghir 2 and 3 (Trinkaus et al. 2014: 295–307).

#### 4.3. Health

##### 4.3.1. Pathologies

Slightly over one third (36%) of the Mid-Upper Paleolithic adolescents in our sample display some form of pathology or abnormality. Likely congenital (i.e., present from birth) pathologies exhibited include the metacarpal growths of the older male adolescent Baouso de Torre 2 (Italy) (Villotte et al. 2011), the supernumerary (extra) teeth of the older female adolescent Abri Pataud 1 (Villotte et al. 2018), and the femoral bowing of the young adolescent Sunghir 3 (Formicola & Buzhilova 2004 cf. Trinkaus 2018). Most notable in this regard is the Dolní Věstonice (DV) 15 adolescent, whose severe ‘pathological’ nature prevented the clear assignation of sex through osteological means (aDNA analysis has recently confirmed this individual—along with the others in this triple burial (DV 13 and 14)—as male; Mittnik et al. 2016). DV 15s extensive developmental abnormalities are mostly post-cranial and include asymmetrical curvature and angular deformities of the proximal femora, asymmetrical shortening of the femora, a diaphyseal deformity of the right distal humerus and anomalies in tooth position and number (Trinkaus et al. 2001). The cause of these abnormalities is unclear (some form of dysplasia is presumed; *ibid.*), and they were further compounded by trauma (fractures of the left forearm likely caused by a fall; Trinkaus 2018).

Several individuals in our database suffered from acquired pathologies, most notably in the form of traumatic injuries. In addition to the post-cranial injuries of DV 15 noted above, this individual also experienced some minor cranial injuries (Beier et al. 2018, Supplementary Information). Further traumatic injuries are recorded for the male adolescent Arene Candide I/ ‘Il Principe’ (a partially healed mandibular injury; Pettitt 2011:182) and the injuries to the right humerus and left radius of the older female adolescent Caviglione 1 (the latter probably the result of a fall; Chevalier 2019).

##### 4.3.2. Cause of death

Cause of death can only be inferred with reasonable certainty for two individuals within our Gravettian adolescent database. Dental histological analysis of the Ostuni fetus (Ostuni 1b), buried *in utero* with Ostuni 1 (a heavily pregnant 20-year-old woman) shows that the fetus experienced three stress events before the death of its mother. These events were extreme enough to disrupt the enamel development of the unborn child, indicating that the mother was under severe physiological stress in the final stages of her pregnancy; whatever the specific cause, it was likely responsible for her death (Nava et al. 2017). Villotte and colleagues (2018) present a convincing case of septicemia initiated by advanced gum disease as the cause of death of the older female adolescent Abri Pataud 1.

Less well understood is the cause of death of the individuals comprising the mass inhumation at Předmostí (MNI = 27) (Svoboda 2008). The individuals include 3 infants, 5 children, 9 adolescents and 4 adults<sup>5</sup>. Accordingly, some have argued that the grave is the result of a catastrophic event; an argument based on the age and sex profile of the individuals uncovered at the site, which resembles a snapshot of a community at one point in time (Zilhão & Trinkaus 2002). Others argue that the skeletons represent a gradual accumulation of bodies (Oliva, 2001a,b; Svoboda 2005, 2007) suggesting that this area of the site functioned as a cemetery of sorts. Complicating matters is the fact that the site was initially excavated in the late 1890’s and early 1920’s, before excavation following a grid system was the norm; instead, the

workers dug in ever widening concentric circles (Svoboda 2007). Notes from these early excavations are incomplete and sometimes contradictory and the location of the grave at the slope of a large limestone rock means that the stratigraphy is complex. More recently, the larger site area has been subjected to extensive post-depositional disturbance related to quarrying activities and virtually all of the excavated skeletal material burnt in a fire in 1945 (Svoboda 2007). Through renewed excavations in 2006 and a meticulous piecing together of primary resources (e.g., diaries, sketches, and photographs), Svoboda (2008) identified three primary taphonomic vectors that were responsible for the disturbance and redeposition of remains—geological processes, predator activity and prehistoric human reuse of the site related to the burial of subsequent bodies. Nonetheless, he argues that the positioning of the bodies (generally north, parallel to the rock face), the relatively complete state of the skeletons when initially excavated, and the location of the remains (both near the rock face and on the periphery of the occupation) suggest that the skeletal accumulation is the product of intentional mortuary practices. He writes (2008, 21), “... a long-term tendency to take the dead outside the actual settlement center (i.e., ‘below the rock’) may have given rise to the accumulation of human remains at a single place, with a scatter of dispersed fragments in the vicinity.” Svoboda’s (2008) interpretation of the site undermines the argument that these adolescents died as the result of a catastrophic event and thus the cause of death in their cases remains unknown.

#### 4.4. Lifestyle

Direct bioarchaeological information on their lifestyles is available for some of the Gravettian adolescents included in our database:

##### 4.4.1. Diet

Stable isotope data—from which the main source of dietary protein can be inferred—are available for four Mid-Upper Paleolithic adolescents. The results present a diverse picture. The young adolescent from Kostenki 18 appears to have had a diet rich in freshwater animal resources ( $\delta^{13}\text{C}$  of  $-19\text{‰}$  to  $-24.7\text{‰}$ ;  $\delta^{15}\text{N}$  of  $13.1\text{‰}$  to  $14.9\text{‰}$ ; Reynolds et al. 2017; Richards et al. 2001). In contrast, the ‘Il Principe’ teenager likely derived up to 25% of his dietary protein from marine resources ( $\delta^{13}\text{C} = -17.6\text{‰}$ ;  $\delta^{15}\text{N} = 12.6\text{‰}$ ) (Pettitt et al. 2003). The  $\delta^{15}\text{N}$  values of the young male Sunghir 2 and 3 adolescents ( $11.2\text{‰}$  and  $11.0\text{‰}$  respectively) combined with analyses of bone mineral composition and post canine buccal microwear indicate a diet derived mainly from herbivore protein, although starchy plants were also important (Dobrovolskaya et al. 2012; Richards et al. 2001; Trinkaus et al. 2014).

##### 4.4.2. Activities

Analyses of activity-related skeletal morphologies provide suggestions of the habitual behaviors of several of the adolescents in our database. Published studies all indicate high activity/mobility levels for these teenage foragers. Villotte and colleagues’ (2017) study of upper limb lateralization of the older male adolescent Baouso da Torre 2 (BT 2), reported an overall robust morphology and high levels of bilateral asymmetry. In combination with evidence for medial epicondyle enthesopathy (i.e., “thrower’s elbow”) on his right side, these findings are consistent with BT 2 participating in strenuous and/or repetitive unimanual tasks, possibly relating to throwing. The robusticity of his lower limbs further indicates high activity levels likely in the form of high mobility across the mountainous local landscape of Liguria (*ibid.*). High upper limb robusticity is also reported for the older female adolescent Caviglione 1. This is despite the aforementioned trauma to her right arm, which saw her switch her dominant side to her left, and which appears—based on the robusticity of her left humerus—to have compensated for any remaining right-side weakness (Chevalier 2019). Notably, the male DV 15 and Sunghir 3 adolescents appear to have led highly active lifestyles despite suffering from the range of congenital and acquired pathologies described above (Cowgill et al. 2015; Trinkaus

<sup>5</sup> These numbers are based on the definitions of age categories given in this paper. The number of individuals in each age category varies depending on the authors’ definition and is therefore not consistent across publications.

et al. 2001).

#### 4.5. Maternity

The aforementioned Ostuni 1 woman, who died at around age 20 years while heavily pregnant (Nava et al. 2017), provides the only firm evidence for age during pregnancy in the Gravettian (and indeed, the whole of the European Upper Paleolithic). Her condition provides a *terminus ante quem* for the end of her period of adolescent subfecundity. As discussed above, the first birth is a common marker of the end of the ‘adolescent’ phase of recent foragers. The age at death estimate of the Ostuni 1 woman thus provides some justification for our widening of the definition of ‘adolescent’ in the Mid-Upper Paleolithic to include those in their early 20’s. However, it is unknown whether this was her first pregnancy, or how representative her experience of pregnancy (both in terms of her age and as the cause of her death) may have been of other Gravettian young women. However, given the aforementioned higher frequency of older female adolescents in our sample, childbirth and maternity may have been a not infrequent cause of death.

### 5. Discussion

As Kamp (2001:4) notes, “like gender, age categories and roles are culturally defined and must be investigated rather than assumed. It is not tenable to assume that specific age categories derived from modern Western models will correspond to socially significant stages for cultures, past or present. In fact, the reverse is true. It should be expected that every society will have its own age categories and its own definitions for childhood.” This begs the question of how we can use the Gravettian archaeological record to identify meaningful categories rather than imposing preconceived categories upon it. Based on the ubiquity of adolescence across all human societies and a principle of uniformitarianism in human biological development, we have previously proposed the existence of a socially meaningful and distinctive adolescent phase among European Upper Paleolithic hunter-gatherers (Nowell & French 2020). The adolescent database presented and analyzed here provides vivid insights into the lives (and deaths) of some Mid-Upper Paleolithic teenagers, and an opportunity to evaluate if and how adolescence was experienced or marked as a distinct life stage in Gravettian society.

#### 5.1. Are adolescents distinct from other age categories?

Table 4 presents a summary of the wider Mid-Upper Paleolithic burial sample. This dataset includes those individuals who do not fall into our adolescent category, divided into infant (1 year old or younger at death), child (1–9 years old at death), and adult (29 years or older at death). Criteria for inclusion in our study are the same as those for the adolescents described above.

##### 5.1.1. Demographic variables (age and sex)

Our broader sample of Gravettian burials includes information on 84 individuals. In addition to the 33 adolescents presented in Table 2, there are 16 infants, 10 children and 25 adults (Table 4; Fig. 1). The greater number of adolescent burials compared to those of younger subadults is possibly due to taphonomy (i.e., older subadults are more likely to preserve in the fossil record than younger ones; Guy et al. 1997) and the width of the age categories (intervals of 1, 9 and 18 years for infants, children, and teens, respectively). It is also possible, however, that there is a behavioral reason for why there are one and half times more known Gravettian adolescent burials than adult burials. It could be that more of them were dying due to risk-taking behavior, first pregnancy or from health complications due to congenital and acute diseases that rendered them unlikely to survive into adulthood, particularly once the social scaffolding often associated with subadults began to fall away. Another possibility is that adolescence is a life history stage that was recognized

as being special in some way and thus (more) deserving of burial. The relative abundance of adolescents in the wider Gravettian mortuary distribution is noted elsewhere in the literature (e.g., Partiot et al. 2020:9).

Sex data are available for 51 of our 84 Gravettian individuals based on skeletal morphology and/or aDNA. Of these individuals, 17 are sexed as female (including 2 possible females) and 34 as male (including 3 possible males). Broken down by age category and including our data on teens, there are 3 male and 0 female infants, 16 male and 11 female adolescents and 15 male and 6 female adults with male to female ratios of 3.0, 1.4, and 2.5, respectively. No sex data are available for children (*sensu stricto*). While the infant data must be treated with caution because of the small sample size, it is interesting to note that while adolescent males and females are relatively equally represented, among adults there were twice as many males as females (the latter observation was also noted by Stiner (2017:253) and Pettitt (2011:211)). The reason for this pattern could be activity related (perhaps adult males more often engaged in dangerous activities such as big game hunting) or adulthood may be associated with a rise in gendered differences and these differences are being expressed in the treatment of the dead.

##### 5.1.2. Mortuary practices

5.1.2.1. *Type of burial.* Variation in the type of burial is evident across our four age categories. Gravettian infants and children were far more likely to be buried with another, older, individual than to be buried on their own. Thirteen of 16 infants were uncovered in double or multiple burials, and with the exception of a pair of identical twins at Krems-Wachtberg (Austria) (Teschler-Nicola et al. 2020), they were all laid to rest with older members of their community. Similarly, 70% of the children in our sample were buried in double or multiple burials with adults, while one occupied a double burial with an infant. By contrast, two thirds of adults were buried in single graves ( $n = 14$ ) with only a third uncovered in double or multiple burials ( $n = 10$ ). Within these age-based patterns, the prevailing burial type of Gravettian adolescents most closely resembled those of the younger members of the community; as described above, most MUP adolescents were interred in double or multiple burials with older individuals, with only ~ one third being laid to rest by themselves.

In terms of location, 56% of infants and 80% of children were buried in open-air sites. Rock shelters served as the burial location for 37% of infants but only 10% of children, while no infants and only 10% of children were buried in caves. Adults were preferentially buried in open-air locales (48%) while 36% were buried in caves and 16% in rock shelters. In this regard, teens bucked the trend with 45.5% buried in caves, 45.5% in open air sites and 9% in rock shelters.

Body position and orientation data were available for only 23 individuals in our non-adolescent database. Of these, 75% of adult females and infants were buried in a flexed position ( $n = 4$  in each case), adult males were evenly divided between flexed or sitting and extended positions ( $n = 10$ ) and children appeared to follow no pattern at all, but we must be cautious about making any interpretations with sample size of 3. Similarly, no pattern was discernible in orientation for any of these individuals. By contrast, the adolescents displayed a clear pattern in body position with 73% of the 19 individuals for which we have data buried in an extended position (but again with no seeming preference for orientation).

5.1.2.2. *Treatment of the body.* Sixty-one percent of the 51 non-adolescents ( $n = 31$ ) displayed some evidence of body treatment and/or interment with ochre. Broken down into age categories this includes 63% of the infants, 50% of the children, and 64% of the adults. If the 12 individuals from the burial pit at Předmostí are excluded, the overall figure of individuals displaying evidence of ochre/body treatment rises to 79% (including all children, all adult females, 83% of infants, 69% of

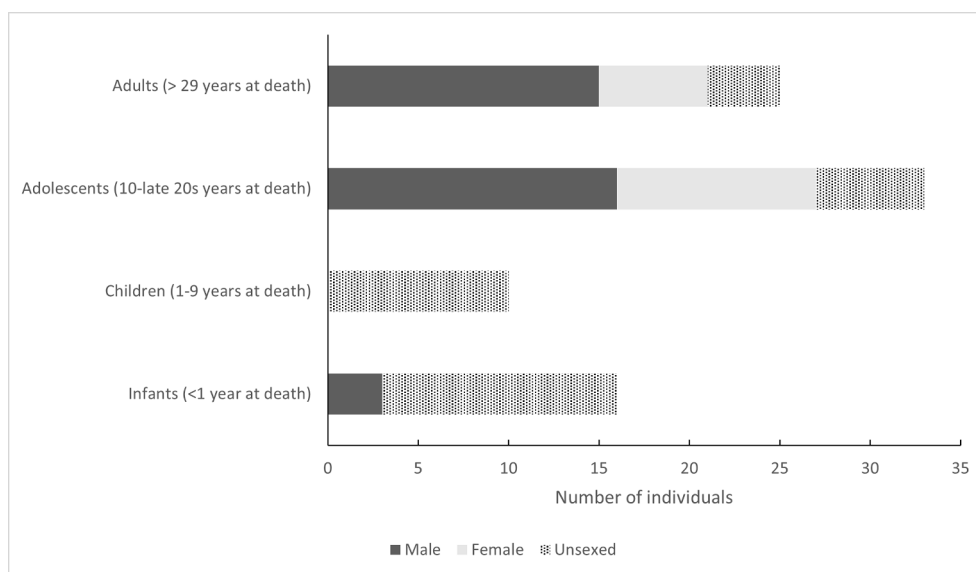


Fig. 1. Demographic profile (age and sex distribution) of the wider Mid-Upper Paleolithic burial sample. See Tables 2 and 4 for full data.

adult males and 50% of the adults of unknown sex). These figures are broadly comparable to that of adolescents, 58% of whom were interred with ochre (rising to 79% of teens when Předmostí is excluded from the database).

In contrast to teens whose heads, faces, and upper torsos were the primary focus of ochre distribution, infants and all adults were more likely to have ochre spread throughout the body, with children showing no discernible pattern with regard to the placement of ochre. Unlike adolescents, for whom the evidence is ambiguous, at least one Gravettian infant—the single burial Krems Wachtberg 2 (Austria)—is believed to have been wrapped in a covering (shroud) prior to burial—an interpretation based on the tightly delimited distribution of ochre and the presence of what appears to be an ivory pin near his head (Einwögerer et al. 2006, 2009). Similar arguments for coverings as part of the burial treatment have been made for the Lagar Velho child (Portugal) (Duarte et al. 1999; Zilhão & Trinkaus 2002) and the Baouso da Torre 1 adult male (Italy) (Villotte et al. 2011, 2017).

### 5.1.3. Grave goods

**5.1.3.1. Artifacts.** Most of the individuals in our wider Gravettian burial database ( $n = 33$  (65%)) were buried with artifactual grave goods. This includes 68% of the infants, 50% of the children, and 68% of the adults compared with 58% of adolescents. Again, when the mass burial at Předmostí is excluded, these figures rise to 85% of the wider database including 92% of infants, all children, 80% of adult females, 79% of adult males and all adults of unknown sex. The overall range of grave goods is similar between adolescents and other age classes, including objects such as ochred shells, incised or perforated fox canines, mammoth ivory beads, and lithic and bone tools.

**5.1.3.2. Other animals and human remains.** Twenty-four individuals in our wider sample (12 of whom derived from the mass burial at Předmostí) were buried in association (or possible association) with animal remains. Examples of individuals of all age classes buried covered by mammoth scapula are found across central and eastern Europe (Brno II, Pavlov I, Předmostí, Dolní Věstonice 3 and 4, Krems-Wachtberg 1a, 1b, Kostenki 15)—a phenomenon only recorded once in our adolescent database, and that may have reached its conceptual ‘peak’ with the burial of Kostenki 2 (an elderly man interred in a chamber constructed of mammoth bones and tusks; Sinityn 2004). Other examples of interment with accompanying animal remains are the

Lagar Velho child, buried with a rabbit placed on their legs and two deer pelvises (one at the shoulder, one at the feet) (Zilhão & Trinkaus 2002), and, more tentatively, a fox skull placed across one of the individuals at Předmostí (Svoboda 2008). There is no unambiguous case—equivalent to that recorded among the adolescents Sunghir 2 and 3—among our wider sample of burial with accompanying human remains, although an association has tentatively been proposed between the Pavlov 1 (adult male) and the isolated elements Pavlov 2, 3 and 4, found adjacent to the Pavlov 1 burial (Svoboda 2006).

The site of Sunghir, where we find burials of both adolescents and adults, provides some unique insights into the possibility that grave goods relate to social norms across age classes. The double burial of the adolescents Sunghir 2 and 3 is notably elaborate within the wider MUP sample, containing an array of artifacts including ivory spears, jewelry, art objects and > 10,000 mammoth ivory beads that were once presumably attached to clothing (Trinkaus & Buzhilova 2018). However, these items are not equally distributed between the two individuals in the burial. Items unique to Sunghir 2 include pierced arctic fox canines, a decorated belt, and animal figurines, as well as the aforementioned isolated element of Sunghir 4 individual. While ivory discs are distributed throughout the grave, most of them are associated with Sunghir 3, as are most of the ivory spears (although the longest of these is placed nearest to Sunghir 2). Based on the earlier attributions of Sunghir 2 as male and Sunghir 3 as female, Trinkaus and colleagues (2014:24) postulated that these differences in artifact association within grave 2 could be related to ideas of ‘maleness’ within the Sunghir community, noting that the presence of pierced fox canines linked Sunghir 2 with the adult male Sunghir 1 at the site, whose grave also contained these items. Recent genetic analysis confirms both individuals in grave 2 as male (Sikora et al. 2017) and undermines this interpretation. However, a meaningful link between the artifacts associated with Sunghir 2 and 1 could be proposed based on age. Although both are classified within our database as ‘young adolescents’, the age differences between Sunghir 2 (aged 12–13 at death) and 3 (aged 9–10 at death) could perhaps reflect the older Sunghir 2 being classed as socially adolescent (and more aligned with the roles and responsibilities of adult men within the Sunghir community) than the younger Sunghir 3 ‘child’.

### 5.1.4. Intra-regional data on burial traditions

While the site level data are limited, intra-regional data are relevant for examining differences in burial traditions that might be related to age categories and roles, with the reduced spatial scale (contrasted with

the continental comparisons above) allowing for some control over the variables of culture and geography. Within our database, Italy provides the best regional sample for assessing possible differences in burial treatment between adolescents and adults that might be related to the ‘marking’ in some form of these different life stages.

There are several characteristics common to all Italian MUP burials in our sample, regardless of the age of the buried individual. For example, all burials are located in caves with all but one also described as an occupation site. Second, an overwhelming majority of these burials (85%) are aligned along the N-S,<sup>6</sup> axis with only 15% of interred individuals aligned in an E-W direction. Third, in other regions, communities sometimes chose to include unmodified human or animal elements in the interments. In Italy, however, with the exception of Paglicci III/25, this appears to be an unknown practice. Finally, two-thirds of teens and adults in this region were buried alone rather than with others.

Other variables, however, serve to distinguish adolescent from adult burials in the Italian MUP. First, as noted above, there is a clear sex bias in who is being buried among the adults (5 males to 2 females and 1 of unknown sex) which is not apparent among adolescents (6 males, 6 females). Second, adolescents were more likely to be laid to rest in an extended position while with adult burials there was no clear preference for one body position over another. One could argue that as a group, adolescents are shorter on average and therefore there was less need for a flexed burial (if investment of labor was a consideration), but the few exceptions to this rule were not the oldest (and tallest) males. This observation suggests that body position was a conscious choice.

Finally, associated grave goods serve to both unite and distinguish adolescent and non-adolescent burials in the Italian MUP. While virtually all the interments were accompanied by ochre or artifacts (and often both), grave goods associated with adolescents were greater in number and variety and the use of ochre was more extensive. The richest adult burial in our sample was Barma Grande 2 who was interred with the adolescents Barma Grande 3 and 4.

### 5.1.5. Health & lifestyle

Evidence from a range of bioarchaeological measures—including high average height and body mass, and fewer generalized stress markers such as dental enamel hypoplasias—has led to the collective characterization of Mid-Upper Paleolithic people as relatively healthy (at least in comparison with both earlier archaic Neanderthal populations and their Late Upper Paleolithic successors; e.g., [Formicola & Holt 2007](#); [Holt & Formicola 2008](#); [Lacy 2014](#); [Niskanen et al. 2018](#)). Those MUP individuals who diverge from this trend and show unusually high levels of generalized stress markers (dental enamel hypoplasias) are adolescents (DV 15 and Sunghir 3). One explanation for this is that adolescents are often more vulnerable to stress and labor related injuries as they begin to take on adult specific tasks with a still developing body (see [Lewis 2016](#); [Perry 2005](#) for examples in Medieval London and the Byzantine Empire, respectively). In the case of DV 15 and Sunghir 3, however, these stress markers are likely primarily linked to their wider pathologies discussed in section 4.3.1 ([Formicola et al. 2001](#); [Guatelli-Steinberg et al. 2013](#)).

Despite the MUP reputation for general good health, several individuals in our wider database suffered from some form of congenital or acquired pathology of varying severity, including the notably short stature and unusual cranial shape of the adult male Cussac L2A (France), the traumatic arm injury and unusual body proportions of the Lagar Velho 1 child, and the scoliosis, femoral deformities, cranial fracture and facial asymmetries of the adult male DV 16 ([Duarte et al. 1999](#); [Svoboda 2006](#); [Villotte et al. 2015a](#)). Given the unclear etiology of many of these pathologies, a comparison between the types of pathologies exhibited by

Mid-Upper Paleolithic adolescents on the one hand, and other age categories on the other, is premature. The frequency of buried individuals suffering from a pathology was, however, higher among adults (40%) and adolescents (36%) than among younger individuals (children = 20%, with no documented pathologies among the Gravettian infants).

Limited direct data makes it difficult to identify specific differences in the lifestyle of Gravettian adolescents that may have marked them as somehow ‘distinct’ from both older and younger age categories. As with the adolescents, cause of death is unknown for all but a few individuals in our wider database; the infants from Krems-Wachtberg (1a and 1b) who likely died as a result of complications during or immediately following their births ([Teschler-Nicola et al. 2020](#)) and the Sunghir 1 man who died from a fatal wound to the T1 vertebra, possibly inflicted through interpersonal conflict ([Trinkaus & Buzhilova 2012](#)). Childbirth is a mortality risk that is obviously shared by both infants during the process of birth and those women (belonging to both our adolescent and adult categories) who are fecund. While both the violent death of Sunghir 1, and the lack of similarly violent deaths among Gravettian adolescents might hint at different roles and activities of adult and teenage males in MUP societies, it is hard to draw any firm conclusions from this isolated occurrence.

Isotopic evidence discussed previously indicates that the diet of Gravettian adolescents was variable across Europe; the isotopic profiles of those individuals belonging to our other age categories are similarly variable ([Richards 2009](#); [Richards et al. 2001](#)). Compared with the wider sample, the adolescent ‘Il Principe’ is notable—though not unique—among EUP/MUP individuals in having an isotopic signature suggesting the increased consumption of aquatic resources ([Richards 2009](#)). Nonetheless, inter-site comparisons of the diets of adolescents vs. non-adolescents are likely to reflect environmental differences in local conditions, rather than possible variation linked to social norms in the diet of people of different ages. More valid comparisons can be made at the intra-site level. The isotopic signatures of the adult Sunghir 1, and the adolescents Sunghir 2 and 3, are all broadly similar, with only small variation in  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values between individuals ([Trinkaus et al. 2014: 295-300](#)). However, isotopic data provide profiles of average dietary protein intake over approximately the last decade of life before the death of an individual ([Richards et al. 2001](#)), thereby cross cutting the age categories employed in this study. Another dietary indicator—buccal dental microwear (specifically the relative proportions of vertical and horizontal scratches)—suggests differences in diet between Sunghir 1 and 2 on the one hand, and Sunghir 3 on the other ([Trinkaus et al. 2014: 301-303](#)); a division mirroring that noted above in the type of artifacts these individuals were buried with and providing further (tentative) support for a possible point of age-based social distinction among the Sunghir community that straddles our ‘young’ and ‘mid’ (true?) adolescent age categories (occurring at around 13 years of age).

Finally, published analysis of both upper and lower limb hypertrophy and muscle attachments indicates that MUP people were highly active and mobile compared to their Late Upper Paleolithic successors ([Holt 2003](#); [Trinkaus et al. 2001](#); [Churchill & Formicola 1997](#); [Villotte et al. 2017](#)). The individuals included in these analyses belong to both our adolescent and adult age categories, although the published data are not disaggregated enough for us to identify possible differences in these measures as they relate to specific individuals included in our databases. However, it is notable that the robusticity measurements of the lower limbs of both the DV 15 and Sunghir 3 adolescents (who, as described earlier, both suffered from multiple pathologies) are comparable to other MUP individuals, indicating that they participated fully in group activities despite their ill health ([Cowgill et al. 2015](#); [Trinkaus et al. 2001](#)). From this we can perhaps deduce that the activities of MUP adolescents and adults were broadly similar. Whether there was a sex-based differentiation in tasks is, however, unclear, with studies of skeletal markers of injury prevalence and dimorphisms in limb robusticity providing support both for (e.g., [Beier et al. 2018](#); [Villotte et al. 2010, 2017](#)) and against (e.g., [Churchill et al. 2000](#); [Holt 2003](#)) different

<sup>6</sup> Eighty-six percent of interments are aligned in N-S, S-N, NE-SW, or SE-NW direction.

habitual activities of men and women.

#### 5.1.6. Limitations of the bioarchaeological database

While the data have allowed us to explore some aspects of the lives of MUP adolescents, we should keep in mind the limitations of the Gravettian bioarchaeological database. Despite comprising the richest bioarchaeological database for the European Upper Paleolithic, the ~84 Mid-Upper Paleolithic burials presented in Table 4 represent only 8.4–10.5 burials/1000 years for the estimated ~8–10,000-year duration of the Gravettian. Our 33 adolescents in Table 2 represent only 3.3–4.1 burials for every 1000 years of the MUP. The clear geographical clustering of MUP burials in key regions (Italy, Czech Republic, France) is also a widely-recognized phenomenon.

For these reasons, the individuals represented by the MUP burial record are a highly selective minority of the Gravettian population. This selectivity is reflected in the unusually high rate of pathologies among buried individuals and the distribution by age and sex of the individuals buried (which does not reflect expected age-specific mortality under normal, attritional, conditions). While a high prevalence of pathologies is not unique to the European MUP within the wider Pleistocene sequence, it may nonetheless have been a criterion for burial (Formicola 2007; Pettitt 2011; Sparacello et al. 2018). Other selecting features for burial have been proposed that might have biased the age and sex ratio of MUP burials. Notable models include Zilhão's (2005) proposal of social differentiation by age class, in which infants were not considered 'persons' in Gravettian society who would warrant formal burial in the case of an early death (resulting in their underrepresentation in the fossil record), and Mussi and colleagues' (1989) proposal that MUP burial in Italy was largely reserved for those who were good hunters (a status that they attribute to adult men and male adolescents). However, both the extent of these biases, and their interpretation remain contested. Nowell (2020) demonstrates the weaknesses in the assumptions of Zilhão's model, highlighting issues of sample size as well as the aforementioned differences in the likelihood of preservation and recovery of the bones of infants vs. older individuals (Guy et al. 1997), and drawing attention to examples of rich Gravettian infant burials (e.g. the Krems-Wachtberg twins), several of whom received burial treatment comparable to older members of their society (e.g., the infants from Cro-Magnon; Partiot et al. 2020). Stiner (2017:253) has also questioned the reality of the sex bias in the Gravettian burial record, suggesting that the high average height and body mass of MUP people discussed above, combined with evidence for relatively narrow hips among both males and females (e.g., Mallegni et al. 2000; Vančata 2003), reduced the sexual dimorphism of this population, which may have resulted in some individuals being erroneously assigned male. Finally, we should be wary of a limitation that affects the interpretation of all skeletal assemblages; that, by definition, those individuals who become part of our skeletal samples at a given age are those who did not survive. It is possible that they are somehow different from those who did and are therefore *a priori* a biased sample of the total population who may have been unusual in some way (the 'osteological paradox'; Wood et al. 1992).

#### 5.2. The Gravettian bioarchaeological database for adolescence in wider perspective

The above discussion on the possible distinctiveness of adolescence within Gravettian society comes with the obvious caveat that bioarchaeological data is just one of several relevant sources of evidence for the lives of adolescents in Mid-Upper Paleolithic societies. Following on from our broad overview of the European Mid-Upper Paleolithic presented earlier in this paper, here we discuss the implications of our bioarchaeological study for two phenomena that are considered emblematic of the Gravettian; 1) an increase in innovations and a flourishing of extended social networks; 2) the emergence of new social hierarchies.

#### 5.2.1. Innovations and social networks

An expansion of the scale of human interactions via extended social networks distinguishes the Upper Paleolithic from earlier stages of the European Paleolithic (French 2021). At the same time, the Upper Paleolithic is also characterized by the rapid (in Pleistocene terms) development and dissemination of new forms of material culture; 'innovations' in the broadest sense (Lew-Levy et al. 2020: 2-3). While debates continue as to how best to characterize and quantify the social networks of Pleistocene foragers (Coward 2016), consensus suggests that the Gravettian (particularly the early phase between ~35 and 29 kya) was a period of particularly notable population connectivity, with hunter-gatherer populations across Europe integrated into robust 'open-systems' (Gamble 1982, 1986), reflected in continent-wide similarities in lithic technology, material culture, and burial traditions (e.g., Borgia 2017; Maier & Zimmerman 2017; Riel-Salvatore & Gravel-Miguel 2013) as well as osteological data that suggest high levels of gene flow across Europe during the MUP (Churchill et al. 2000; Holt 2003; Holt & Formicola 2008; Mounier et al. 2020; Trinkaus & Svoboda 2006). Similarly, while new developments occur throughout the Upper Paleolithic, many notable innovations are seen for the first time in the MUP, including substantial artificial structures and storage facilities (e.g., Pryor et al. 2020), organic technologies related to weaving and basketry (Soffer et al. 2000), ceramic technology (Farbstein & Davies 2017), plant-grinding tools (Revedin et al., 2015) and boomerangs (Valde-Nowak et al. 1987).

It was during the Upper Paleolithic that Europe was occupied for the first time by *Homo sapiens*; 'modern humans' who experienced the same slow pace of development and extended period of adolescence common to our species (e.g., Partiot et al. 2020). Hominins mature much more slowly than other primates and this attenuation of the human life course has resulted in the insertion of two unique life history stages into the typical primate pattern—childhood (defined as the period from weaning to the eruption of the first permanent molar) and adolescence (the period from the onset of the adolescent growth spurt to the cessation of growth and maturation). This slowed growth allows subadults more time to learn from the adults around them and from their peers. In their study of non-human primates, Street et al. (2017) found that longevity and social learning are positively correlated. Species with a greater emphasis on social learning also tended to live longer, suggesting that there was selection for not only increased time for learning but for opportunities to make the most of that learning (Nowell 2021; Nowell in press; Riede et al. 2021). Over a 2-million-year period, extended juvenility and encephalization in hominins evolved in tandem with notable expansion of areas of the brain that are implicated in learning including the cerebellum, neocortex, basal ganglia and hippocampus (Scalise Sugiyama 2011). Thus, there may have been selection for parents to invest in what Scalise Sugiyama (2011) refers to as 'cognitive capital'.

Elsewhere, (Nowell & French 2020), we have argued for a key role of this emerging adolescence in both the expansion of social networks and the spread of ideas and innovations in the Late Pleistocene. Underpinning this hypothesis is a growing body of ethnographic data that suggests that adolescents in hunter-gatherer societies—being both highly creative and having time to explore and take risks due to their minimal subsistence and caring obligations (Hewlett & Hewlett 2012)—are "active acquirers of innovations" (Lew-Levy et al. 2020: 12). In combination with another key feature of hunter-gatherer adolescence listed in Table 1—the tendency of adolescents (particularly male adolescents) to engage in long-distance exploration in the search for marriage and sexual partners—teenage foragers are proposed as primary vectors for the transmission of innovations within and between groups (Hewlett 2021; Lew-Levy et al. 2017, 2020; Nowell 2021).

The Gravettian, as a particular period of innovation and connectivity with the European Upper Paleolithic, would form an ideal case-study to test (albeit somewhat indirectly) this hypothesis. Current bioarchaeological data present an ambiguous picture. As discussed above, evidence from lower limb robusticity measures, as well as some genetic

(Loog et al. 2017), and isotopic (Lugli et al. 2017) data suggest that MUP people were highly mobile (more so than the Late Upper Paleolithic successors). However, there is no evidence of which we are aware to suggest that adolescents were more mobile than other age/social groups. The presence of seemingly ‘unique’ items, or those that have traveled long-distances in the burials of adolescents could hint at a key role of adolescents in the transmission of innovations between groups in the MUP. The best examples of these sorts of items come from the adolescent burials of Arene Candide 1 and Barma Grande 3 and 4. At both of these Italian sites, teens were buried with ivory ornaments. Due to the near absence of mammoths in southern France and Italy during the Gravettian, ivory was an extremely rare raw material (Formicola & Holt 2015; Giacobini 2006, 2007; Mussi 2002; Onorotini et al. 2012). Furthermore, as Formicola and Holt (2015:79) note, “ivory carving requires experience and skill that can only be acquired in Central or Northern Europe where the material is abundant.” Additionally, long blades made from flint originating in the Lure Mountain in southeastern France several hundred kilometers away were uncovered from both burials. Finally, the burial of Arene Candide 1 also contained several *bâtons percés* (or “*bâtons de commandement*”). These artifacts made from antler are known from the French Aurignacian and are considered to be generally exotic to Italian sites as they are found only in the northwest of the country (Liguria) where Arene Candide is located (Mussi 2002). Little other evidence for exotic/long distance items can be associated with Gravettian adolescents with certainty but this remains an avenue worthy of further exploration.

### 5.2.2. The emergence of new social hierarchies

The hunter-gatherers of Mid-Upper Paleolithic Europe are often viewed as emergent examples of ‘complex’ hunter-gatherers (e.g., Bender 2005; Hayden & Villeneuve 2011; Soffer 1985; Zilhão 2005); hunter-gatherer groups characterized by traits including logistical mobility strategies, large, semi-sedentary settlements, storage, and social hierarchies (e.g., Arnold 1996; Kelly 2013: Chapter 9). The evidence from burials plays a central role in the characterization of Gravettian groups as ‘complex’ hunter-gatherers who lived in stratified societies. In particular, the instances of ‘rich’ or elaborate burials of children and adolescents described above are frequently taken as proxies for a system of ascribed (or inherited) social status (e.g., White 1999).

Recent studies have questioned the evidence for the emergence of social hierarchies in the MUP as reflected in the burial evidence. Based on their analysis of the associated grave goods, d’Errico and Vanhaeren (2015) argue that variation in MUP burials is best explained by geography, reflecting ethnolinguistic diversity and cultural norms rather than temporal change, raw material availability, or social hierarchies (see also Nowell 2020; Riel-Salvatore & Gravel-Miguel 2013). Wengrow and Graeber (2015) highlight the limitations of the database, drawing particular attention to the aforementioned high rate of physical abnormalities. They combine the anomalous appearance of many of these buried individuals with the richness of the accompanying grave goods to suggest that “the ostentatious display of personal wealth was ritually associated with the same kind of ‘otherness’ seen as inherent in anomalous or exceptional individuals... Such burials were exceptional in every sense and can hardly be interpreted as simple proxies for social structure among the living” (*ibid.*: 605).

Furthermore, as Nowell (2020) notes, the binary used in archaeology—which characterizes prehistoric cultures as either simple or complex, egalitarian or hierarchical—is overly simplistic. It is more than just the size of forager groups that varies seasonally as part of the ‘fission-fusion’ pattern typical of hunter-gatherers (Aureli et al. 2008). These cycles of regular group aggregation and dispersal have substantial social ramifications, with the same population potentially experiencing vastly different systems of economic relations, family structure and political life depending on their current position along the fission–fusion continuum (Wengrow & Graeber 2015). This fluidity, and its impact on the archaeological record, is rarely taken into account in interpretations

of MUP social and political organization. While in our analysis we have found some variables that distinguish adolescents from other age categories, relating these differences to the emergence (or not) of new social hierarchies in the Gravettian remains difficult. Much like our examination of differences in burial traditions that might relate to age categories and the changing roles of individuals across each life stage, exploration of the relationship(s) between burials and social and/or political organization in the European MUP is best conducted at the regional, rather than continental level, where greater control over the variables of culture and geography hold the best promise for incorporating the fluidity of hunter-gatherer social systems into our interpretations.

## 6. Conclusion

Adolescence is a period of transition from childhood to adulthood biologically, cognitively, socially, and often spiritually. However, it is more than simply a shift from one state to another. It is also a unique stage of life unto itself, a period of (self) exploration and intense relationships, when individuals begin to take or, rather, try on, adult roles often without the serious consequences that accompany these roles later in life. For this reason, we can expect adolescence to have been a noted and notable phase of life related to, but differentiated from, childhood and adulthood in the Gravettian. Building on a general framework of adolescence in Upper Paleolithic hunter-gatherer societies (Nowell & French 2020), we explored the direct bioarchaeological evidence for the lived lives of adolescents in the Gravettian/MUP, including placing them in a wider context by comparing them with buried individuals of other age categories (Table 5).

Our findings suggest that adolescents were valued members of society. They appear to have eaten a similar diet to others in their community, with variations in diet more clearly related to regional/environmental differences rather than to age class, and they are characterized by similar activity levels. While Gravettian populations are generally healthy, 36% of teens had congenital or acquired pathologies and in that they are similar to the adults in our sample. Adolescents are particularly vulnerable to injury, disease, and stress as they begin to take on adult tasks while still developing physically; furthermore, the kind of

**Table 5**

Summary of key burial variables and their differences across Mid-Upper Paleolithic burials of different age classes. Sample size for each age category varies according to variable under consideration; see text for details.

	Infants (<1 years at death)	Children (~1–9 years at death)	Adolescents (~10–29 years at death)	Adults (>29 years at death)
Male: Female ratio	3.0	n/a	1.3	2.5
Predominant burial type	Multiple	Multiple	Multiple	Single
Predominant location (site type)	Open-air	Open-air	Sheltered (cave)	Open-air
Most common body position/arrangement	Flexed	No pattern	Extended	Flexed (females) No pattern (males)
Evidence of body treatment and/or interment with ochre (% of individuals)	63	50	58	64
Predominant ochre distribution	Whole body	No pattern	Upper body (heads, faces, upper torso)	Whole body
Presence of grave goods (% of individuals)	68	50	60	68
% of individuals with recorded pathology	0	20	36	40

protection and social scaffolding associated with children starts to fall away as adolescents reach adulthood such that physical challenges that may not have been a significant hindrance in childhood may be a greater burden in late adolescence. Finally, adolescents were as likely as others to be interred with ochre and a wide range of grave goods and in Italy, their burials were often richer.

Conversely, there is some evidence that adolescents were subjected to different social norms. For example, distinctions between male and female adolescents are less apparent than with adults, and teens of both sexes were equally likely to be buried, suggesting that gendered differences took on new significance in adulthood. The ethnographic literature on hunter-gatherer adolescence points to differences between male and female adolescents (Hewlett & Hewlett 2012); either these differences were codified in the Gravettian as well but were not manifest in burial practices or they were not recognized during this period.

The data presented in this paper are preliminary and we suggest three directions for future research. First, are there gendered/sex-related differences between adolescents? Building on our hypothesis that risks associated with first pregnancy were likely a leading cause of death in late adolescent women, further exploration of diet, stress markers, and activity related pathologies in conjunction with expanded aDNA testing may tell us more about any lifestyle differences between the sexes. Second, did what it mean to be an adolescent change throughout the Upper Paleolithic, and did it vary geographically? Answering this question will require comparative datasets to be established for the rest of the Upper Paleolithic in addition to more regional comparisons. A detailed look at the Italian burials revealed some patterning that was lost when the data were considered on a continental scale. Finally, can we distinguish between early, mid, and late adolescence? For example, distinctions in grave goods and diet between the two adolescents of different ages-at-death at Sunghir can be tentatively interpreted as providing an emic perspective on the beginning of adolescence as defined by Pleistocene hunter-gatherers. This is a model that can be tested and further refined.

In the past decade in human evolutionary studies, we have moved from an excavation of Paleolithic children to an archaeology of Paleolithic children where questions related to their lived lives have taken center stage. A similar focus on adolescence in the coming years will only further enrich our understanding not only of this stage of the human life course but of Paleolithic communities more broadly.

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Appendix A. Supplementary data

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