9. Health in medieval Ireland: the evidence from Ballyhanna, Co. Donegal

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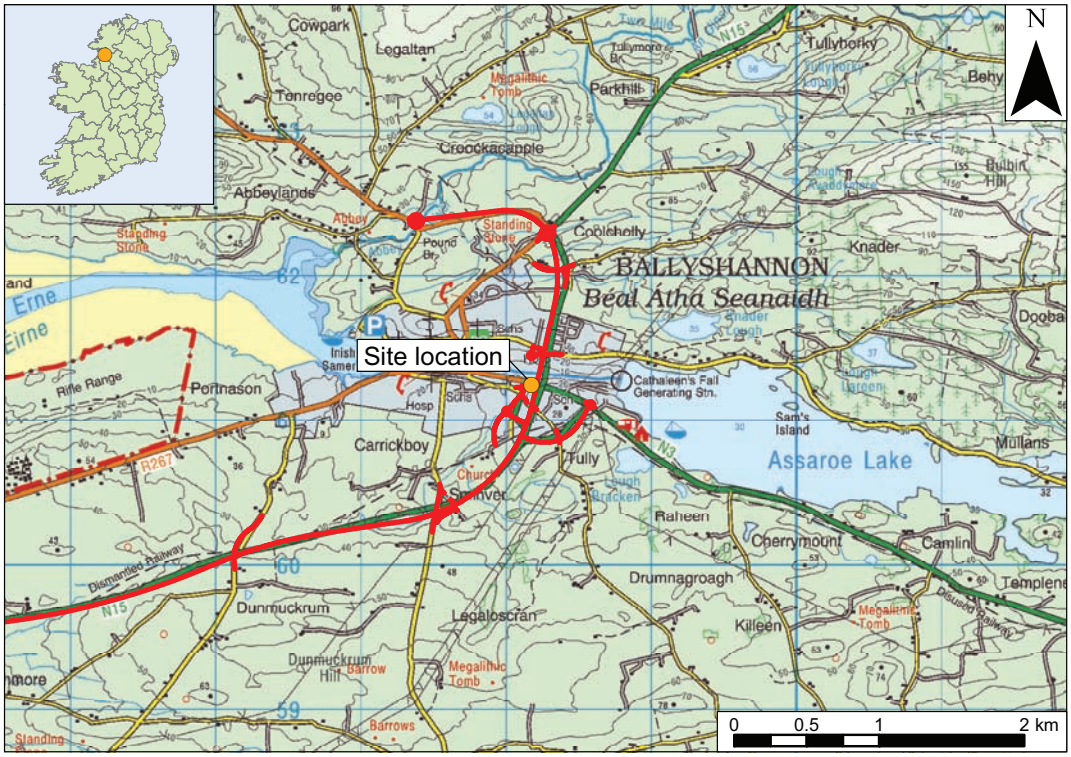


Illus. 1—Location of Ballyhanna cemetery site, Co. Donegal (based on the Ordnance Survey Ireland Discovery Series map).

Ballyhanna is a townland in County Donegal on the southern bank of the River Erne, approximately 1.5 km from the town of Ballyshannon. In the summer of 2003 human skeletal remains were uncovered during archaeological testing prior to the construction of the N15 Bundoran–Ballyshannon Bypass (Illus. 1). The skeletons were excavated by Brian Ó Donnchadha of Irish Archaeological Consultancy Ltd (IAC Ltd) over the winter months of 2003 and the spring of 2004, and during the course of the excavation the foundations of a small stone church were uncovered (Ó Donnchadha 2007; MacDonagh 2008).[1] In total some 1,301 individuals—men, women and children—had all been laid to rest in the cemetery at Ballyhanna. Initially, the dating of the cemetery was dependent upon artefactual evidence, with the presence of silver pennies and medieval pottery indicating that the site was likely to have been in use during the late medieval period. Subsequently, an extensive AMS (Accelerator Mass Spectrometry) radiocarbon dating programme undertaken at Queen's University, Belfast (QUB), indicated that the earliest individuals buried at Ballyhanna were

[1] NGR 188165, 361198; height 15 m OD; excavation licence no. 03E1384.

laid to rest in the eighth and ninth centuries, during the early medieval period, but that the vast majority of individuals had been interred during the late medieval period, between the 13th century and the 16th century (see Appendix 1 for details).

The research presented in this paper was undertaken as part of the Ballyhanna Research Project, a cross-border academic partnership between QUB and the Institute of Technology, Sligo (ITS), which is funded by the National Roads Authority (NRA). The main aim of the Ballyhanna Research Project is to facilitate scientific research on the Ballyhanna skeletal collection, primarily through bioarchaeology, biomolecular science and analytical chemistry, and to disseminate the results to the widest possible audience (a dedicated monograph on the project is currently in preparation and will be published in 2012). The bioarchaeological aspect of the research was undertaken at QUB and involved the osteological and palaeopathological analysis of the skeletal collection.

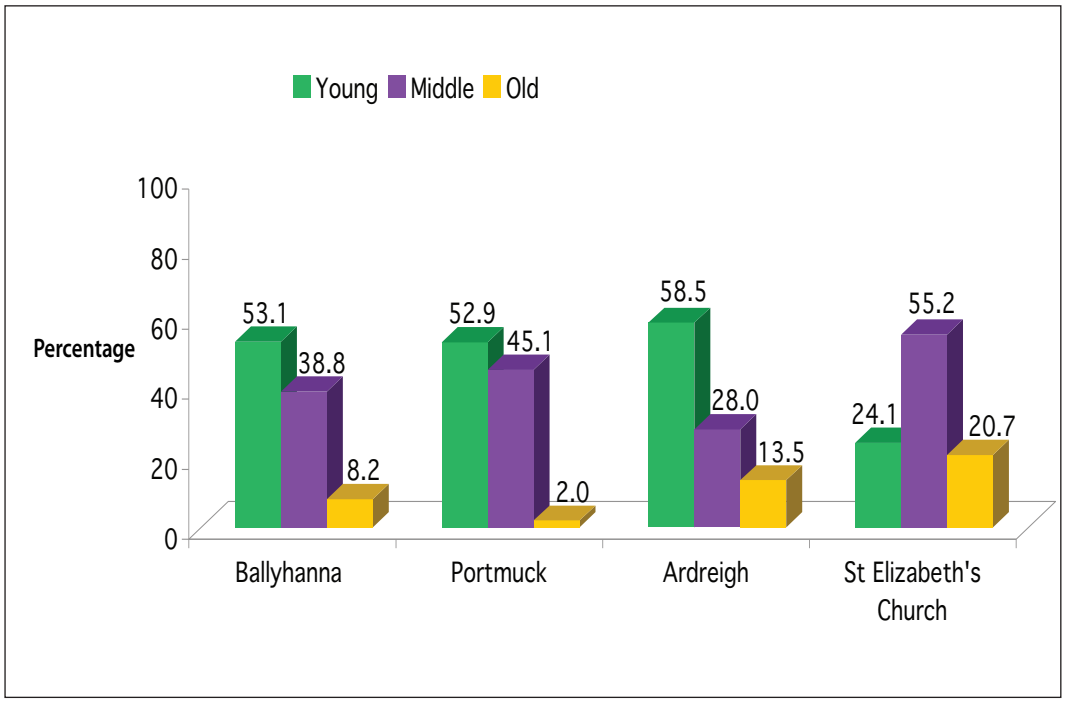
The purpose of the study is to further our understanding of health in medieval Ireland. As part of this, the following paper provides an overview of the main discoveries from the osteoarchaeological analysis of the adult bones. The results from Ballyhanna will be compared with information derived from three other Irish populations of comparable date and will go some way towards furthering our general understanding of health in medieval Ireland (see Table 1). These three sites were chosen because the same methodological techniques were used in the analysis of the skeletal remains by the osteoarchaeologists. The paper will begin with an examination of the mortality pattern and estimated living stature values at Ballyhanna and will then consider the results obtained from the study of four pathological lesions—which are collectively referred to as non-specific indicators of physiological stress (i.e. lesions evident in the skeleton caused by malnutrition, dietary deficiencies, infections or childhood illness).

Table 1—Skeletal collections used for comparative purposes.

Site	Period	No. of males	No. of females	Author
Portmuck, Co. Antrim	Early medieval	47	9	Murphy 2006
Ardreigh, Co. Kildare	Late medieval	365	401	Troy 2010
St Elizabeth's Church, Co. Down	17th century	14	23	Murphy & McGranaghan 2010

Mortality profile

When undertaking the analysis of a skeletal population it is important to determine whether the group under scrutiny represents a population which is likely to be representative of every member of the community. For example, in *cilliní* (unconsecrated burial grounds) the skeletons of young infants predominate and it is therefore clear that a skeletal collection derived from a *cillín* would not be representative of an average population. At Ballyhanna there were 869 adult and 432 non-adult skeletons present for analysis. Of the adult skeletons it was only possible to identify the sex of 655 individuals, of whom 323 were males and 332 were females. The ratio of males to females was close to the expected 1:1.05 (Chamberlain 2006, 18) of a normal population and as such it can be



Illus. 2—Mortality profile of medieval skeletal collection from Ballyhanna compared with similar data from three other sites of comparable date in Ireland.

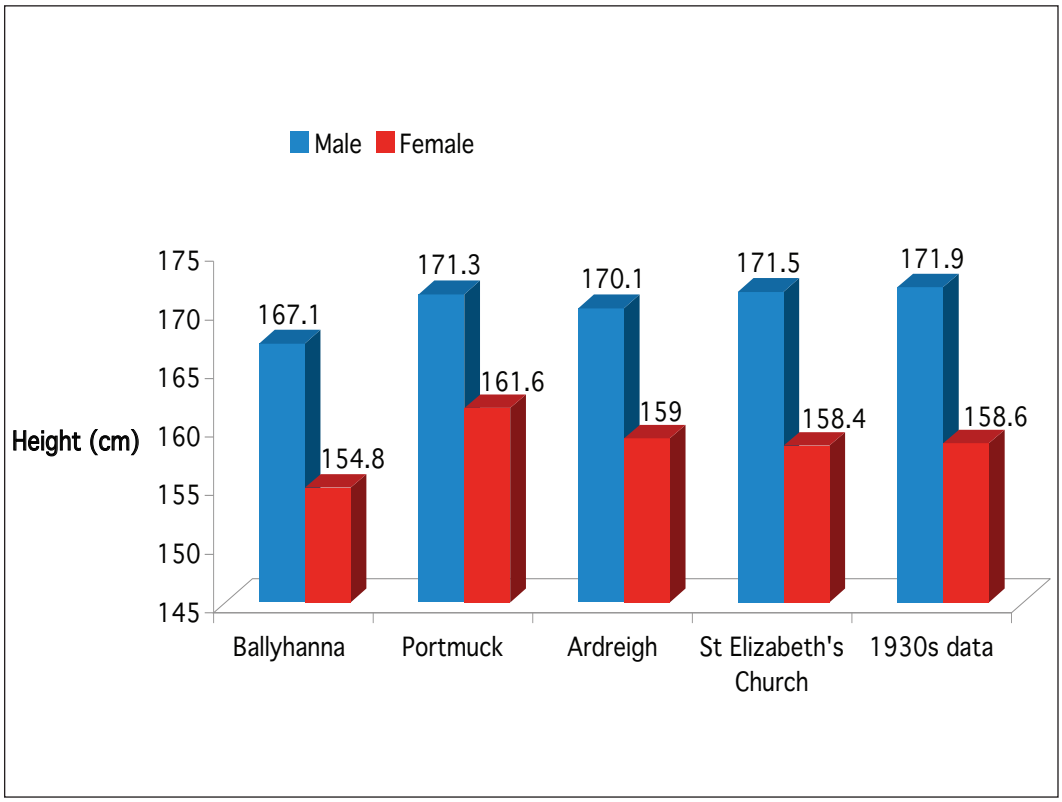
concluded that the skeletons at Ballyhanna are representative of a typical population.

One of the first means of identifying the general health status of a community is to look at life expectancy. Communities with good health tend to live to older ages than those beset by poor health. At Ballyhanna it was possible to age some 539 of the adult skeletons of known sex. Estimation of age at time of death is notoriously difficult in adult individuals and, as such, the most up-to-date guidelines suggest that large age brackets should be used to compensate for inaccuracies in the various ageing methodologies. The Ballyhanna adults were categorised as follows: young adult (18–35 years), middle adult (35–50 years) and old adult (50+ years).

The mortality pattern at Ballyhanna was very similar to the mortality patterns at both Portmuck, Co. Antrim (Murphy 2006), and Ardreigh, Co. Kildare (Troy 2010). At Ballyhanna 53.1% of adult individuals were dying in the young age category; this is very similar to Portmuck, where 52.9% were dying in the younger age category. The data were only slightly worse for Ardreigh, where some 58.5% of adults failed to survive past 35 years of age. In contrast, in the post-medieval skeletal collection from St Elizabeth's Church, Co. Down (Murphy & McGranaghan 2010), it was found that most people were dying at 35–50 years of age (55.2%), while a sizeable proportion of adults (20.7%) were living until they were 50 years of age or older (Illus. 2).

Stature

Further evidence of the health status of the population at Ballyhanna can be found through an assessment of the estimated heights that the individuals would have had when they were



Illus. 3—Estimated average heights of adults during life. The male 1930s data show the stature of west Donegal men, while the female data show the average stature of females of the Irish west coast.

alive. Height is influenced by genetics, diet and health. Communities that have a good diet and a good state of health will reach their optimal genetic heights, whereas communities with poor diets and a low standard of health will fail to reach these levels. As such, the estimated average heights of individuals in life may provide a good indication of the diet and health status of the community as a whole.

The average height of the Ballyhanna individuals indicated that the adults in this community were short in stature. Male heights ranged from 152.6 cm to 179.4 cm and the mean height was 167.1 cm, while females ranged in height from 142.7 cm to 164.5 cm, with an average height of 154.8 cm. Illus. 3 shows the data from Ballyhanna compared with those derived from the other Irish populations included in the study.

It is clear that the average heights at Ballyhanna are notably lower than those of other similar skeletal collections. The possibility that genetics are at play needs to be excluded, however, and it is necessary to ask to what degree are the shortened heights at Ballyhanna typical of the genetic profile of adults in the Donegal region across time? In 1934–6 a team of anthropologists from Harvard University came to Ireland to investigate the physical attributes of adults across the island, and they measured over 8,000 men and over 2,000 women (Hooton 1940). During the 1930s the males (171.9 cm) in west Donegal were comparable in height to the national average (172.02 cm). It should be noted that these data refer only to the heights of the Roman Catholic males in Donegal, as the Protestant males were considered likely to be the descendants of Scottish immigrants and therefore not native to the island. The Catholic Donegal men were more likely to be the descendants of

those buried in medieval Donegal and, as such, it is interesting that there is no evidence of shortened stature owing to genetics among the men of west Donegal in the early 20th century. This finding may indicate that the shortened statures at Ballyhanna are more likely to have been the result of poor nutrition and poor health during childhood rather than genetic factors.

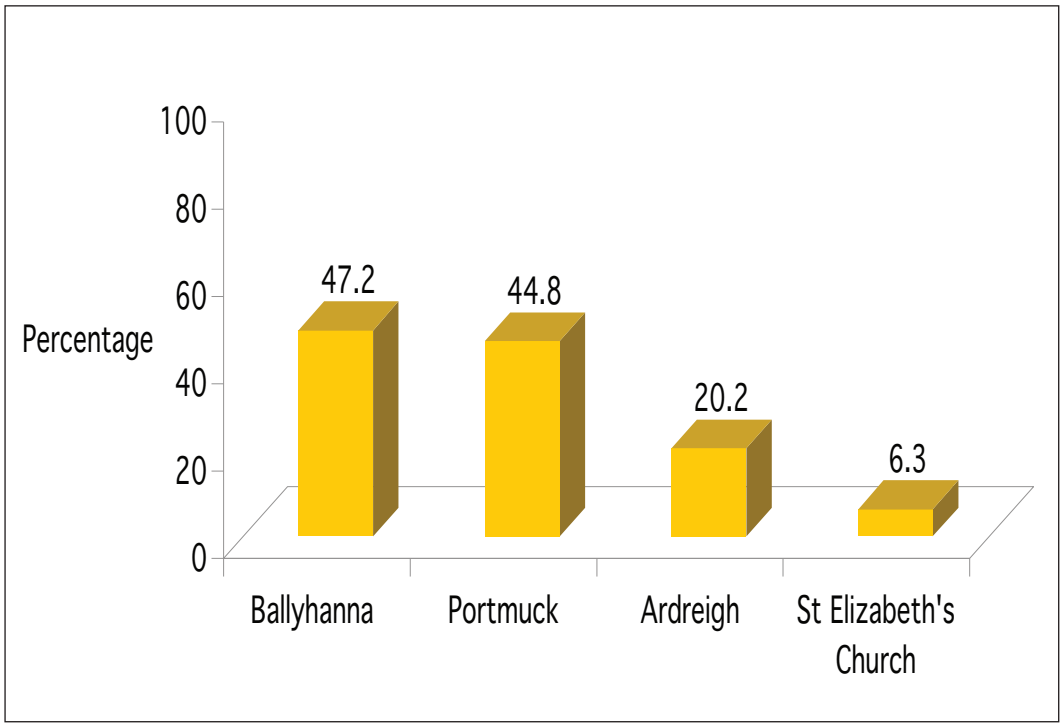
Non-specific indicators of physiological stress

Non-specific indicators of physiological stress are lesions that are evident in the skeleton and may be caused by malnutrition, dietary deficiencies, infections or childhood illnesses. The work of Goodman et al. (1984) has emphasised the key role that the environment plays with regard to physiological stress since it provides not only the resources needed for survival but also associated stressors. Cultural systems can help to buffer a society against stressors, but some stressors, such as warfare and social disruption, can also be culturally induced. Depending on the strength of the individual's immune system, the stressors can then cause physiological disruption or stress to the skeleton, which is manifested in disruption to growth and the development of disease and can ultimately result in death. It is therefore clear that physiological stress can have serious negative consequences on a population and can result in a decreased level of health, a reduced ability to undertake work, a suppressed reproductive capacity and general sociocultural disruption.

Cribra orbitalia

The term 'cribra orbitalia' refers to porosity on the orbital roofs (Illus. 4). Until relatively recently, cribra orbitalia was thought to be caused by iron-deficiency anaemia in childhood. A recent study by Walker et al. (2009), however, has suggested that the link between cribra

Illus. 4—Cribra orbitalia in the orbital roofs of a male adult (SK 8) from Ballyhanna (Catriona McKenzie).



Illus. 5—Rates of cribra orbitalia.

orbitalia and iron-deficiency anaemia is weak. They have indicated that the lesions may have been caused by a multitude of conditions, including chronic infections and deficiencies of vitamins B_{12}, C and D. They propose that a combination of poor diet, a lack of hygiene, infectious diseases and cultural practices associated with pregnancy and breastfeeding might explain the high levels of these lesions in many past populations.

Almost half (47.2%; 59/125) of the adult individuals from Ballyhanna with orbital roofs present for analysis displayed cribra orbitalia (Illus. 5). The rates of cribra orbitalia were slightly higher than those reported for the Portmuck population, in which 44.8% of adult individuals displayed the condition. In contrast, the rates of cribra orbitalia were substantially lower among the skeletons from both Ardreigh and St Elizabeth's Church. The high levels of these lesions in the Ballyhanna population may therefore provide an indication that the population had suffered from a poor diet and perhaps a susceptibility to infection.

Porotic hyperostosis

Porotic hyperostosis is evident on the cranial vault as localised porosity accompanied by widening of the cranial bones (Illus. 6). Traditionally, both cribra orbitalia and porotic hyperostosis were thought to have been caused by iron-deficiency anaemia during childhood. Again, Walker et al. (2009) have challenged this interpretation and have suggested that porotic hyperostosis is likely to be due to haemolytic and megaloblastic anaemias, which most commonly arise from deficiencies of vitamin B_{12} and vitamin B_9 (folic acid). Vitamin B_{12} is mostly found in meat products and depleted levels of the vitamin are therefore generally found in individuals whose diet is largely vegetarian. Vitamin B_{12} is stored in the liver and a deficiency in an adult develops very slowly, but in children the

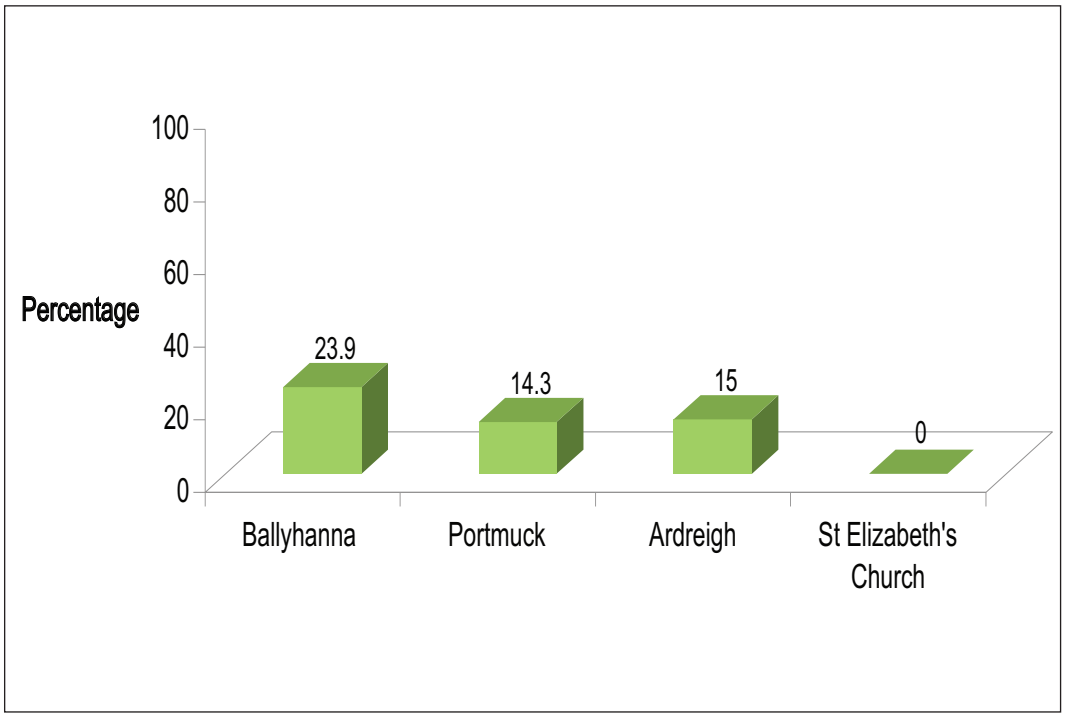
Illus. 6—Porotic hyperostosis in an old (50+) adult male (SK 757B) from Ballyhanna (Catriona McKenzie).

deficiency may become apparent within months of their birth, and particularly if fed by mothers who have a depleted supply of the vitamin themselves. Gastrointestinal infections deplete the nutritional status of an individual and are the most common cause of vitamin B_{12} deficiency in an adult whose diet includes some meat.

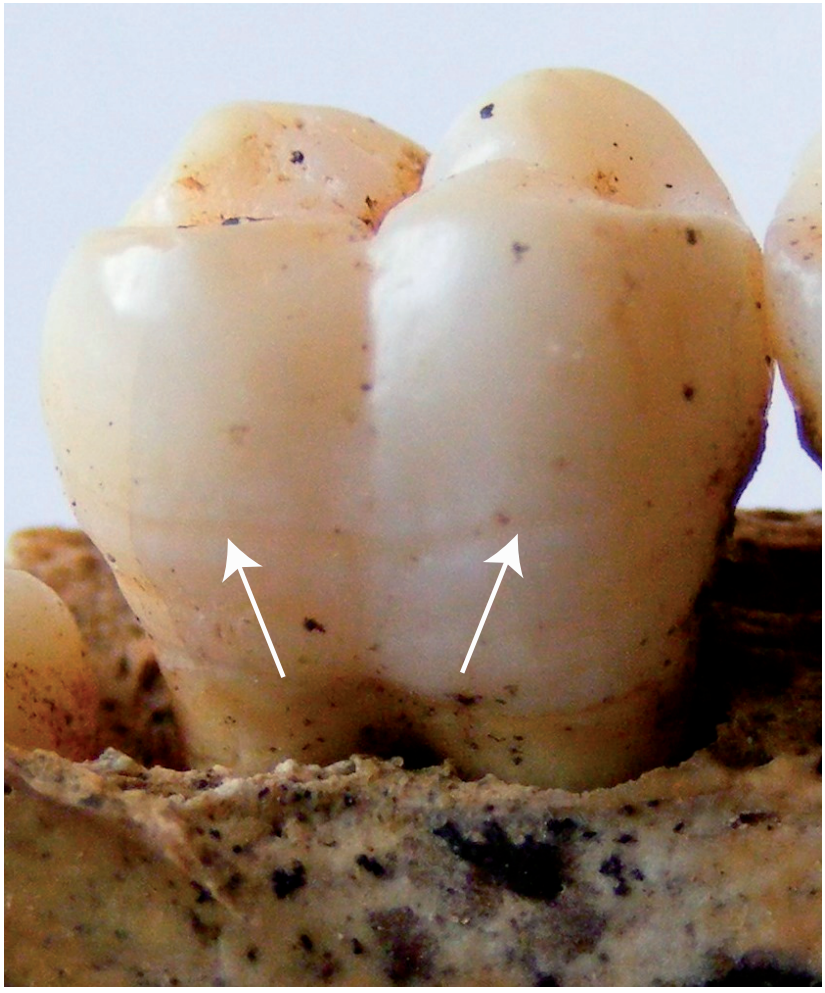
Almost a quarter of all of the Ballyhanna adult individuals with cranial vaults present for analysis showed lesions indicative of porotic hyperostosis. Illus. 7 shows the rates of porotic hyperostosis at Ballyhanna compared with the other three Irish skeletal collections. It is clear that the rates at Ballyhanna are substantially higher than in the other skeletal collections and it is interesting to note that at St Elizabeth's Church none of the adult individuals were affected by porotic hyperostosis.

Dental enamel hypoplasia

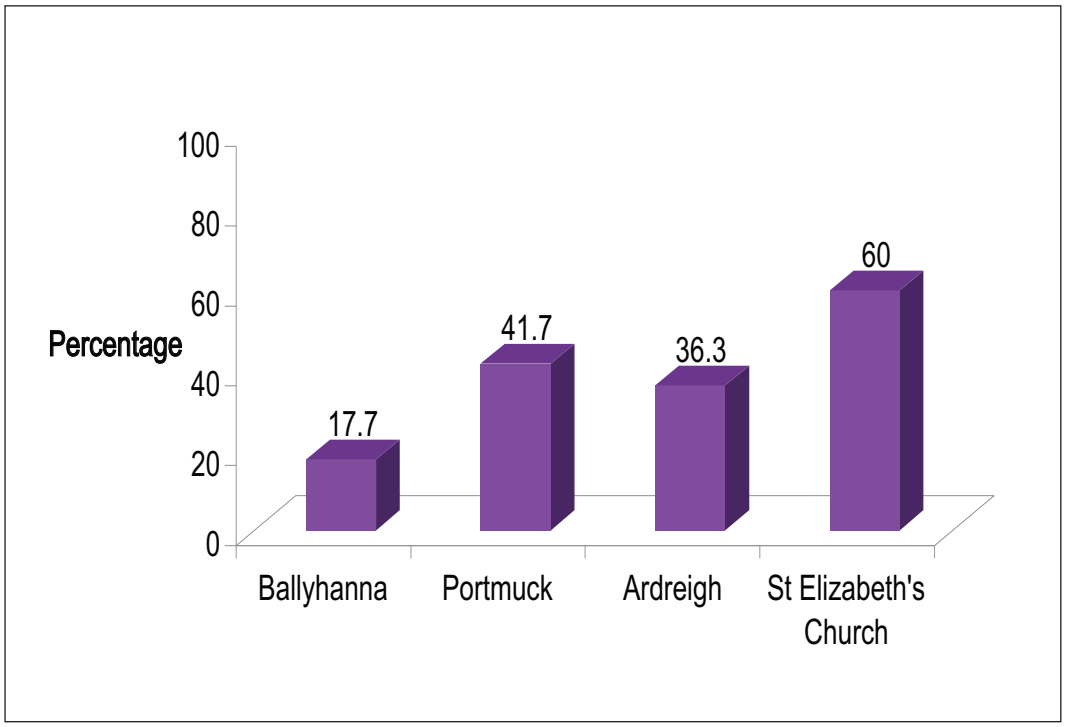
The third non-specific indicator of physiological stress examined in the current study is dental enamel hypoplasia. The term 'enamel hypoplasia' is used to refer to defects in the enamel that occur during the formation of the crown of the tooth. The defects may be evident as depressions, grooves, lines or pits (Illus. 8) and are formed by a cessation in the development of the tooth during a period of physiological stress. Once a hypoplastic defect has occurred in the enamel it cannot be removed, since enamel does not have the ability to remodel. Consequently, a hypoplastic defect on a tooth acts as a memory of an incident of physiological stress which affected the individual when their teeth were developing during



Illus. 7—Rates of porotic hyperostosis.



Illus. 8—Linear enamel hypoplasia in a young (18–35) adult female (SK 217) from Ballyhanna (Catriona McKenzie).



Illus. 9—Rates of enamel hypoplasia.

childhood. In modern populations enamel hypoplastic defects are linked to fever, starvation, congenital infections, low birth weight and parasite infections.

The rates of enamel hypoplasia at Ballyhanna were lower than those reported from the other three comparable Irish skeletal collections (Illus. 9). At Ballyhanna 17.7% of all adult dentitions displayed enamel hypoplasia, compared with 41.7% and 36.3% of adult dentitions at Portmuck and Ardreigh, and 60% at St Elizabeth's Church.

Tibial periosteal new bone formation

Periosteal new bone formation is reactive new bone growth that occurs at the outermost layer of bone surface (Illus. 10). Reactive new bone formation can occur as a result of inflammation in infectious processes, as a result of direct trauma or as a consequence of other disease processes which cause physiological stress. The tibia (shin bone) is considered to be the bone most sensitive to the development of periosteal reactive new bone formation, probably as a consequence of its close proximity to the skin and its propensity for suffering frequent minor injuries, such as bumps and bruises.

Periosteal new bone formation was apparent on 11.1% of the adult tibiae present for analysis. Exactly the same proportion of adults from St Elizabeth's Church had periosteal new bone formation evident on their tibiae, while a similar percentage of adults from Ardreigh displayed the lesions. The only notable difference was in the skeletons from Portmuck, which displayed lower rates of new bone formation at this location (Illus. 11).

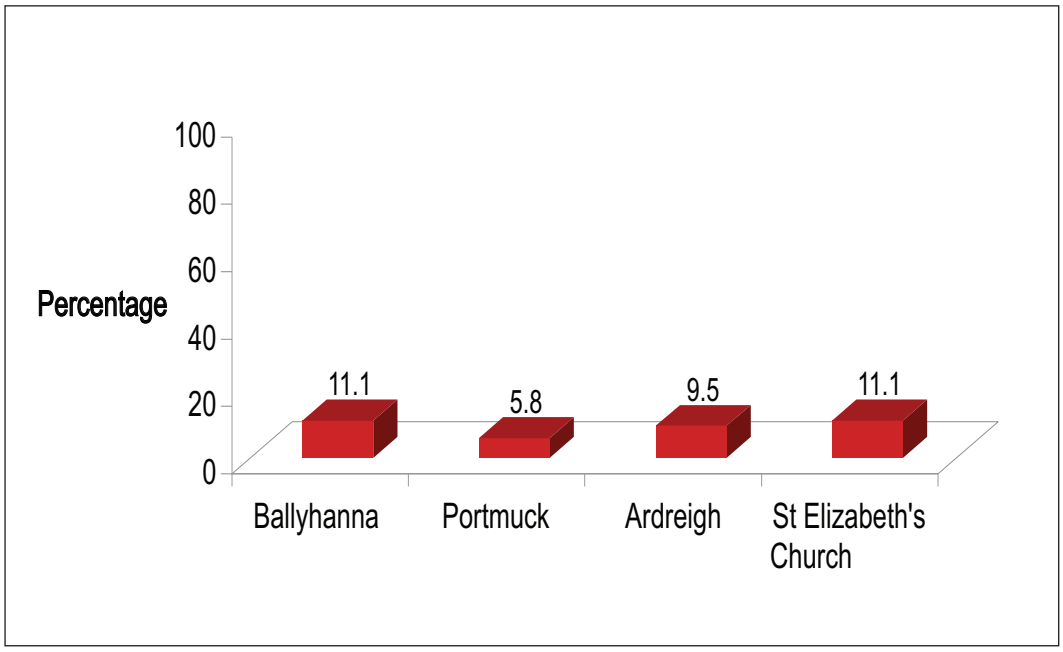
Illus. 10—Periosteal new bone formation on the distal tibia of an adult of indeterminate sex (SK 535) from Ballyhanna (Catriona McKenzie).

Discussion

The purpose of this paper was to explore osteological indicators that might help to deduce the overall health of the community buried at Ballyhanna. By looking at six of these indicators and by comparing them with data collected from three other Irish sites we can now make the following deductions. It is clear from an examination of the mortality pattern that the individuals at Ballyhanna were dying at a relatively young age, with just over half passing away before they had reached the age of 35 years. This pattern was very similar to the mortality profiles for both the Portmuck and Ardreigh populations and may suggest that this shortened life expectancy was the norm for Irish medieval populations. The skeletal collection from St Elizabeth's Church is 17th-century in date and these skeletons were excavated from the interior of the church. It is likely that these individuals represent the wealthiest in society and when compared with the earlier medieval populations the life expectancy at St Elizabeth's Church is indeed longer, with over half of the individuals (55.2%) living until middle age (35–50 years) and a sizeable proportion (20.7%) living into older age.

The adults at Ballyhanna were notably shorter than their contemporaries in the other Irish skeletal collections and this could have been due to malnutrition and ill health in childhood and/or genetics. When the non-specific indicators of physiological stress are examined collectively, Ballyhanna has the highest rates of cribra orbitalia, porotic hyperostosis and tibial periosteal new bone formation (Table 2; Illus. 12). Conversely, the Ballyhanna adults displayed the lowest frequencies of dental enamel hypoplasia.

In order to understand how we can determine the overall health of the individuals at Ballyhanna there is one key point that must be stressed—pathological lesions only occur in human bones when the immune system is reacting to the initial pathological insult. For example, in the case of enamel hypoplasia a child may contract measles accompanied by a fever. The fever may stop the formation of the enamel at the tooth crowns for the duration

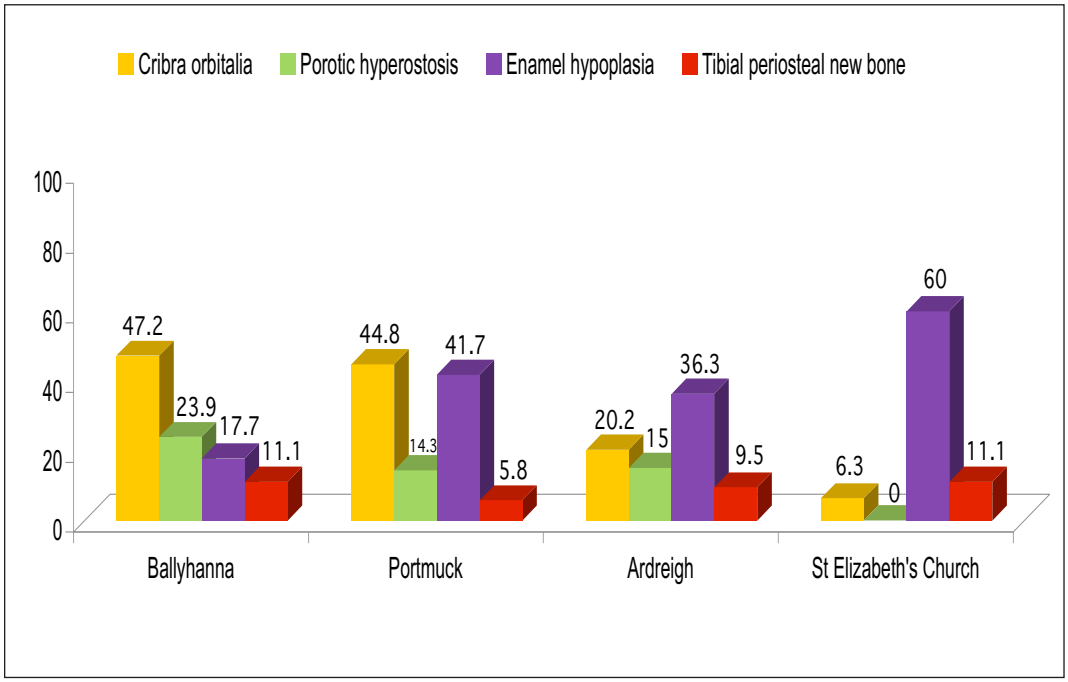


Illus. 11—Rates of tibial periosteal new bone formation.

Table 2—Prevalence rates of non-specific indicators of physiological stress. Each of the prevalence rates represents the percentage of adults affected, with the exception of tibial periosteal new bone formation, in which the percentage represents the percentage of bones affected in each skeletal population.

	Ballyhanna	Portmuck	Ardreigh	St Elizabeth's Church
Cribra orbitalia	47.2% (59/125)	44.8% (13/29)	20.2% (145/718)	6.3% (1/16)
Porotic hyperostosis	23.9% (73/305)	14.3% (5/35)	15% (78/519)	0
Dental enamel hypoplasia	17.7% (63/356)	41.7% (15/36)	36.3% (195/537)	60% (9/15)
Tibial periosteal new bone formation	11.1% (59/532)	5.8% (4/69)	9.5% (97/1,019)	11.1% (3/27)

of the illness. If the child recovers, the enamel deposition will begin again and the hypoplastic defect will be left in the tooth as a permanent marker of that period of ill health. If, however, the child dies during the period of illness, further enamel will not be formed and the tooth will not continue to grow, and so there will be no indication of the period of illness on the dentition of the affected child. Thus a skeleton with no pathological lesions may represent either an individual who was not ill and therefore has no evidence of disease in their skeleton, or a person who was ill but whose immune system was too frail



Illus. 12—Summary of prevalence rates of non-specific indicators of stress.

to fight the illness and who died during the acute phase of the disease before pathological lesions became evident on the bones. This difficulty of interpretation is referred to as the osteological paradox.

At a community level, how can we tell the difference between a healthy community with no pathological lesions and a community in which health was relatively poor but which also shows no pathological lesions? To answer this question one must reassess all the strands of evidence that are available. If people are healthy and are dying with no evidence of disease in their bones, then they are presumably living longer owing to their good health and diet. It can be argued that this is the situation for the population buried at St Elizabeth's Church, in which the majority of people are living into middle age and where the average stature is tall and comparable with statures recorded for individuals living in Ireland during the 1930s. Furthermore, the population buried at St Elizabeth's Church showed the lowest rates of cribra orbitalia and no cases of porotic hyperostosis, although their rates of enamel hypoplasia were the highest recorded and the frequency of tibial periosteal new bone formation was comparable with the data collected from both Ardreigh and Ballyhanna. It is likely that the data from St Elizabeth's Church are indicative of the healthiest of the four Irish communities examined. Given that the population was surviving to older ages than the other three communities and that their stature is probably consistent with optimal genetic stature, it is likely that the low rates of cribra orbitalia and porotic hyperostosis indicate that the overall health of the community at St Elizabeth's Church was relatively good. The high rate of enamel hypoplasia among the adults shows that when the children in this community did get sick they were likely to recover and survive into adulthood. The rate of periosteal new bone formation was similar to the levels recorded for the other communities and this may indicate that all four of the populations were almost equally

likely to suffer from bumps and bruises during the course of everyday life.

In contrast, the data from Ballyhanna present a different picture. At Ballyhanna just over half of the adult individuals were dying before they reached the age of 35 years. Their heights were shorter than those recorded for the other comparable skeletal collections. The Ballyhanna skeletons also have the highest rates of cribra orbitalia and porotic hyperostosis. The rates of enamel hypoplasia are low but it is likely that this is because the general health of the community was low and children who developed a fever, or who were suffering from malnutrition or other diseases, were more likely to die than recover. The rates of tibial periosteal new bone formation were similar to those recorded for the other populations and this may just indicate that the adults at Ballyhanna were not affected by injuries or infections of their lower legs to any greater extent than the other medieval populations included in the study. Overall, the mortality profile at Ballyhanna is similar to those from the other two Irish medieval skeletal collections, but the population was clearly under stress, as evidenced by the high rates of cribra orbitalia and porotic hyperostosis. Overall, the findings would tend to suggest that Ballyhanna was fairly typical of a medieval Irish population—the majority of people were failing to live beyond 35 years of age and poor health and nutritional stress were prevalent within the population, a situation which would clearly have had a significant negative impact on their daily lives.

Conclusion

The Ballyhanna skeletal population is of the utmost importance since it is the first large corpus of Gaelic medieval individuals to have been excavated and rigorously studied by osteoarchaeologists. The vast majority of medieval skeletal collections previously excavated have originated from areas that would have been predominantly under Anglo-Norman influence and are likely to contain a mixture of indigenous and incoming peoples. While there are numerous historical documents—annals, genealogies and bardic poems—that provide an invaluable insight into the lifestyles of the higher classes within Gaelic society, there is still relatively little information available on the lower classes, who would have accounted for the majority of the population. The osteological data derived from Ballyhanna have provided important insights concerning the health of the community buried there. It is apparent that life would have been difficult for these people. The very fact that a large number of adults did not live beyond 35 years of age would undoubtedly have had an impact on their surviving children, who may well have found that they had to grow up very fast and take charge of their own survival and that of their younger siblings—all in an environment where they lived under the constant threat of disease and malnutrition.

Acknowledgements

The authors would like to thank NRA Senior Archaeologist Michael MacDonagh and the NRA for funding the Ballyhanna Research Project, Carmelita Troy (Headland Archaeology Ltd) and Kildare County Council for providing unpublished data on the Ardreigh skeletal collection, Brian Ó Donnchadha and the excavation team from IAC Ltd, and Dr Colm Donnelly (QUB) for comments on an earlier version of the text.