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Incidental Findings on Brain MRI: Insight from HUNT MRI - A General Population Study

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Abstract

The aim of the study was to assess the prevalence of incidental findings on brain Magnetic Resonance Imaging (MRI) in a general population of middle aged adults. In addition, the clinical impact, follow up and postoperative outcome resulting from uncovering an incidental finding during a research study were examined.

Brain MRI was performed in a general population as part of the Nord-Trøndelag Health Study (HUNT), which is a multiphase, multipurpose health study on the inhabitant's ≥ 13 years in the county of Nord-Trøndelag, Norway. Only standard MRI exclusion criteria were applied to participant selection. In total, 1006 HUNT participants (530 women) between 50 and 66 years were included.

The cohort was representative for the population, but participant versus non-participant assessment demonstrated a somewhat better health profile of those included in HUNT MRI. Scanning was performed on one 1.5T scanner with a comprehensive scan protocol, all scans were read by two senior neuroradiologists and presence of intracranial findings were evaluated based on patient hospital records and medical history obtained by phone interview.

The prevalence of incidental findings on brain MRI was 29% and 15% of the relatively healthy, middle aged adults participating in HUNT MRI were referred to some type of follow-up. Acquired and developmental cerebrovascular pathologies (silent infarctions, excessive white matter hyperintensities relative to age, aneurysms, occlusion/stenosis of arteries, arteriovenous malformation, and cavernous hemangioma) were most common, followed by extra- and intra-axial brain tumors (meningioma, pituitary tumors, glioma or vestibular schwannoma). Intracranial intervention was performed 1.4% of the cohort with one postoperative deficit, giving a prevalence of 0.1% for a postoperative neurological deficit as a result of brain MRI in a research setting.

Based on the HUNT MRI cohort, about 1 in 7 middle aged participants from the general population will require clinical follow up if undergoing brain MRI scanning in a research setting. Unrecognized excessive white matter hyperintensities and silent strokes were frequent findings, and demonstrate a significant potential for different types of measures aimed at preventing and/or ameliorating unidentified arteriosclerotic disease to maintain brain health in even quite healthy middle aged adults.

Keywords: Neuroepidemiology; Sex differences; White matter lesions; Neurosurgery

Abbreviations: MRI: Magnetic Resonance Imaging; CI: Confidence Interval; HUNT: Helseundersøkelsen i Nord-Trøndelag (Nord-Trøndelag Health Study)

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Introduction

Brain Magnetic Resonance Imaging (MRI) is increasingly used in both the clinic and research studies. In both settings, incidental findings, i.e., image findings not related to the clinical problem and/or unbeknownst to the participant can be encountered. Surprisingly, we know little about the actual prevalence of incidental findings. The literature reports highly variable numbers, most likely due to large variability in the methodologies used and populations included [1-5]. Also, for a finding to be incidental, it should not have been described previously with medical imaging methods or be likely based on the patient history. This information is often difficult or impossible to obtain. The HUNT MRI study was designed to assess the true prevalence of incidental findings on brain MRI in the general middle aged population by combining an epidemiological approach coupled with access to regional hospitals' radiological and clinical patient data, and participants' medical history obtained by phone interview [6]. Types of follow up and outcomes were also recorded.

Review

The Nord-Trøndelag Health Study (HUNT) is a multiphase, multipurpose health study on the inhabitants ≥ 13 years in the county of Nord-Trøndelag, Norway [7]. The HUNT study started in the mid-1980s and has been repeated about every 10th year since. The inclusion criteria for enrolment in HUNT MRI were previous participation in HUNT1 (1984-86), HUNT2 (1995-97) and HUNT3 (2006-08), and not having any of the standard MRI contraindications. Participation rate for the cohort aged 50- 66 at time of HUNT MRI was approximately 90% in HUNT-1, 80% in HUNT-2 and 70% in HUNT-3. Of those invited to HUNT MRI, 27% declined participation, which included those with MRI contraindications. Thus, participation rates in the general HUNT surveys and HUNT MRI are all at excellent to acceptable levels. To further assess the representativeness of the HUNT MRI cohort, a participant versus non-participant study was performed utilizing the wealth of questionnaire and clinical data gather in HUNT. In summary, HUNT MRI participants had a somewhat higher level of education, and lower body mass index and blood pressure compared to both invited non-participants and non-invited individuals [8]. However, the differences were small, albeit significant.

All participants were scanned on the same 1.5 T General Electric scanner with the same comprehensive protocol. In the HUNT MRI cohort, the prevalence of incidental findings on brain MRI was 29% [95% Confidence Interval (CI) of 26-32%]. Indeed, most intracranial findings were incidental (83% [95% CI 79-87%]), while the remaining findings were previously described in hospital records and/or fitted with patient history as related over the phone. However, incidental findings encompassed a range of lesions from minor developmental anatomical variants such as septum pellucidum to findings with life changing impact such as glioma. Still, when considering only those incidental findings which led to referral for further diagnostic procedures or treatment, these findings made up the bulk of all incidental intracranial findings. Indeed, 15% [95% CI 13-17%] of the relatively healthy, middle aged adults participating in HUNT MRI were referred to some type of

follow up. Various acquired and developmental cerebrovascular pathologies (e.g., silent infarctions, excessive white matter hyperintensities relative to age, aneurysms, occlusion/stenosis of arteries, arteriovenous malformation, cavernous hemangioma) were most common, representing 91% [95% CI 86-95%] of the incidental findings with clinical impact. The second largest group of incidental findings with clinical impact was extra- and intra-axial brain tumors with 9% [95% CI 4-13%] of the cohort having meningioma, pituitary tumors, glioma or vestibular schwannoma. Intracranial interventions were performed in 14 individuals (1.4%, [95% CI 0-2%]), mainly aneurysm interventions. Postoperative deficit (a visual field defect) was present in only one participant undergoing surgery for a Spezler-Martin grade 2 arteriovenous malformation, giving a prevalence of 0.1% (95% CI 0-0.03%) for a postoperative neurological deficit as a result of brain MRI in a research setting. In 4% [95% CI 0-8%] of the entire cohort, one or more additional neuroimaging procedures was performed to verify or rule out the presence of a suspected intracranial tumor or aneurysm. The overall positive predictive value of the initial MRI diagnosis was 0.90.

The HUNT MRI cohort demonstrated that incidental findings on brain MRI were a frequent occurrence in the general population. Furthermore, most incidental findings have clinical impact and require some type of follow up; e.g., additional neuroimaging, referral to general practitioner or neurosurgeon. Since HUNT MRI was a quite healthy cohort [8] and all findings were checked against patient records and patient medical history, it seems unlikely that the prevalence of incidental findings was overestimated in the study. Nevertheless, the number of incidental findings on brain MRI was higher in this study than in most published studies, particularly the earlier studies [1-5,9-16].

The reasons are manifold, but include: 1) The HUNT MRI scan protocol: same comprehensive clinical protocol used for all participants; 2) All images were read by two senior neuroradiologists [17-19]; and 3) Inclusion of middle aged subjects, as prevalence of cerebrovascular disease and intracranial tumors increases with age [4,10].

Conclusion

Based on the HUNT MRI cohort, about 1 in 7 middle aged participants from the general population will require clinical follow up if undergoing brain MRI scans in a research setting. This number is notably greater than the 1 in 37 reported in a guideline on the management of incidental findings detected during MRI research [20]. Such a high prevalence of incidental findings with clinical impact on brain MRI underscores the importance of having established good routines for appropriate clinical handling of findings before start of a study to ensure consistent, timely and proper follow up. Moreover, screening to avoid including participants with incidental findings on brain MRI seems futile. On a more positive note, unrecognized excessive white matter hyperintensities and silent strokes were the most frequent of all incidental findings, which demonstrates a significant potential for different types of measures aimed at preventing and/or ameliorating unidentified arteriosclerotic disease to maintain brain health in even quite healthy middle ages adults.

Availability of Data and Materials

All data is available through the HUNT administration for details (<https://www.ntnu.edu/hunt/data>).

Funding

The Nord-Trøndelag Health Study (The HUNT Study) is collaboration between HUNT Research Centre (Faculty of Medicine, Norwegian University of Science and Technology NTNU), Nord-Trøndelag County Council, Central Norway Health Authority, and the Norwegian Institute of Public Health. The study was financed by Liaison Committee between the Central Norway Regional Health Authority (RHA) and the Norwegian University of Science and Technology (NTNU), and the National Norwegian Advisory Unit for functional MRI methods.

Ethics Approval and Consent to Participate

The study was approved by the HUNT study board of directors and the Helse Midt-Norge regional ethics and health research committee, REK midt (2011/456). All participants were adults and legally competent and gave their informed written consent.

Author's Contributions

The author was involved in all phases of HUT MRI from scanner set up to data analysis and manuscript preparations.

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References

- 1 Kim BS, Illes J, Kaplan RT, Reiss A, Atlas SW (2002) Incidental findings on pediatric MR images of the brain. *AJNR Am J Neuroradiol* 23: 1674-1677.
- 2 Katzman GL, Dagher AP, Patronas NJ (1999) Incidental findings on brain magnetic resonance imaging from 1000 asymptomatic volunteers. *JAMA* 282: 36-39.
- 3 Weber F, Knopf H (2006) Incidental findings in magnetic resonance imaging of the brains of healthy young men. *J Neurol Sci* 240: 81-84.
- 4 Morris Z, Whiteley WN, Longstreth WT, Weber F, Lee YC, et al. (2009) Incidental findings on brain magnetic resonance imaging: systematic review and meta-analysis. *BMJ* 339: b3016.
- 5 Sandeman EM, Hernandez Mdel C, Morris Z, Bastin ME, Murray C, et al. (2013) Incidental findings on brain MR imaging in older community-dwelling subjects are common but serious medical consequences are rare: a cohort study. *PLoS ONE* 8: e71467.
- 6 Haberg AK, Hammer TA, Kvistad KA, Rydland J, Müller TB, et al. (2016) Incidental Intracranial Findings and Their Clinical Impact; The HUNT MRI Study in a General Population of 1006 Participants between 50-66 Years. *PLoS ONE* 11: e0151080.
- 7 <https://www.ntnu.edu/hunt>
- 8 Honningsvag LM, Linde M, Haberg A, Stovner LJ, Hagen K (2012) Does health differ between participants and non-participants in the MRI-HUNT study, a population based neuroimaging study? The Nord-Trøndelag health studies 1984-2009. *BMC Med Imaging* 12: 23.
- 9 Gur RE, Kaltman D, Melhem ER, Ruparel K, Prabhakaran K, et al. (2013) Incidental findings in youths volunteering for brain MRI research. *AJNR* 34: 2021-2025.
- 10 Vernooij MW, Ikram MA, Tanghe HL, Vincent AJ, Hofman A, et al. (2007) Incidental findings on brain MRI in the general population. *N Engl J Med* 357: 1821-1828.
- 11 Seki A, Uchiyama H, Fukushi T, Sakura O, Tatsuya K (2010) Incidental findings of brain magnetic resonance imaging study in a pediatric cohort in Japan and recommendation for a model management protocol. *J Epidemiol* 20: S498-S504.
- 12 Kumar RSP, Price JL, Rosenman S, Christensen H (2008) Incidental brain MRI abnormalities in 60- to 64-year-old community-dwelling individuals: data from the Personality and Total Health Through Life study. *Acta Neuropsychiatrica* 20: 87-90.
- 13 Al-Shahi Salman R, Whiteley WN, Warlow C (2007) Screening using whole-body magnetic resonance imaging scanning: who wants an incidentaloma? *J Med Screen* 14: 2-4.
- 14 Yue NC, Longstreth WT, Elster AD, Jungreis CA, O'Leary DH, et al. (1997) Clinically serious abnormalities found incidentally at MR imaging of the brain: data from the Cardiovascular Health Study. *Radiology* 202: 41-46.
- 15 Gupta SN, Belay B (2008) Intracranial incidental findings on brain MR images in a pediatric neurology practice: a retrospective study. *J Neurol Sci* 264: 34-37.
- 16 Shoemaker JM, Holdsworth MT, Aine C, Calhoun VD, de La Garza R, et al. (2011) A practical approach to incidental findings in neuroimaging research. *Neurology* 77: 2123-2127.
- 17 Cooper L, Gale A, Darker I, Toms A, Saada J (2009) Radiology image perception and observer performance: how does expertise and clinical information alter interpretation? Stroke detection explored through eye-tracking. In: Sahiner B, Manning DJ (eds.) *Medical Imaging: Image Perception, Observer Performance, and Technology Assessment*. Proceedings of SPIE, 7263: 72630K p: 12.
- 18 Cooper L, Gale A, Saada J, Gedela S, Scott H, et al. (2010) The assessment of stroke multidimensional CT and MR imaging using eye movement analysis: does modality preference enhance observer performance? In: Manning DJ, Abbey CK (eds.) *Medical Imaging: Image Perception, Observer Performance, and Technology Assessment*, Proceedings of SPIE, 7627: 76270B.
- 19 Lesgold A, Rubinson H, Feltovich P, Glaser R, Klopfer D, et al. (2014) *Expertise in a complex skill: diagnosing x-ray pictures*, revised edition, Psychology Press, New York, US, p: 464.
- 20 Radiologists TRC (2011) *Management of incidental findings detected during research imaging*. Royal College of Radiologists, London.