Components of genetic counsellor education: A systematic review of the peer-reviewed literature

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Abstract The need for appropriately trained genetic counsellors to support genetic healthcare is now acknowledged. However, while programmes for education of genetic counsellors exist in a number of countries, these do not conform to any specific international standards. As genetic techniques, educational standards and professional standards have been evolved, and with increasing mobility of genetic counsellors, it is of great importance to have some comparison of education and training between different countries. This systematic review was conducted to determine the components of educational programmes for genetic counsellors worldwide that have been published in peer-reviewed literature. Databases were searched for studies published in English from 2000 to 2014 related to the topic. We identified 406 potential papers, of these, 11 studies met the inclusion criteria. The findings indicate that, in most cases, the theoretical components of genetic counsellor programmes conform to the recommendations and requirements of relevant professional bodies. However, clinical

preparation of genetic counsellors in real-life professional practice settings seems to be less well addressed as this is essential to ensure genetic counsellors are able to provide safe patient care after graduation. Further work to gain agreement internationally on genetic counsellor education is needed.

Keywords Genetic counsellor · Education · Clinical practice · Programme content

Introduction

The rapid advancement of genetics has resulted in an increase in the application of genetics to many aspects of healthcare (Calzone et al. 2013). In parallel with the higher demand on genetic services, an increasing number of health professionals working in the field is required (Yashar and Peterson 2013; Hooker et al. 2014). Genetic services, including diagnosis of genetic conditions, genetic counselling and genetic testing, are provided in many countries by a multidisciplinary specialist genetic healthcare team, including allied health professionals such as genetic nurses and genetic counsellors (Hooker et al. 2014; Skirton et al. 2013a).

Genetic counselling, which is an integral part of genetic services, is defined by the National Society of Genetic Counsellors (NSGC, p. 5) as ‘the process of helping people understand and adapt to the medical, psychological and familial implications of genetic contributions to disease’ (ACGC 2013). Genetic counsellors are health professionals with specific specialist training in this field (Skirton et al. 2010a; ACGC 2013).

The first training programme for non-medically trained genetic counsellors was founded in 1969 by Melissa Richter at the Sarah Lawrence College in Bronxville, New York (USA). It was established in response to the advances in human genetics knowledge and technologies, which coincided with the

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decriminalisation of abortion and the growing importance of bioethical issues in the USA (Stern 2009; Yashar and Peterson 2013). This first training programme served as the model for the education in genetic counsellors throughout North America. Over the next decades, additional programmes were established in both the USA and Canada (Smith 1993). Currently, there are more than 30 training programmes accredited by the American Board of Genetic Counselling (Cordier 2013). In the late 1980s, educators in South Africa established an MSc level training programme for genetic counsellors (Kromberg and Krause 2013), and in Australia, a diploma level programme was developed: this was later converted to a 2 year Master programme in 2008 (McEwen et al. 2013). In Europe, Master degree programmes for genetic counsellors started in the UK, in 1992 at the University of Manchester and in 2000 at Cardiff University (Skirton et al. 2013b). In the last decade, professionals in other nations have followed in the footsteps of those inaugural models by creating specific educational programmes for genetic counsellors (Cordier et al. 2012). In Europe, the European Board of Medical Genetics (EBMG) assessed those Master programmes offered in Europe by comparing the course delivery methods and content of each programme with the core competences for genetic counsellors and the curriculum developed by the EBMG (Skirton et al. 2013a). The EBMG approved six specific university-based programmes offered in Europe as appropriate for the training of genetic counsellors (EBMG 2014a); these are provided in the UK (Manchester and Cardiff), France, Spain, Portugal and Romania.

As scientific knowledge and application of genetic technology continues to create more diagnostic and management options in clinical medicine, genetic counselling must continue to evolve to meet the needs of populations (Yashar and Peterson 2013; Hooker et al. 2014). In order to ensure quality of patient care, genetic counselling training should include the knowledge, skills and attitudes required to perform appropriately as a genetic counsellor (Accreditation Council for Genetic Counseling ACGC. Standards of accreditation for graduate programs in genetic counseling 2013; Skirton et al. 2013b). Core competencies for the genetic counselling profession have been established in several regions (Yashar and Peterson 2013; Skirton et al. 2013a; Accreditation Council for Genetic Counseling ACGC. Standards of accreditation for graduate programs in genetic counseling 2013). In a Delphi study, Skirton et al. (2013a) determined the first core curriculum for genetic counsellors in Europe that includes the following: (1) counselling skills; (2) psychological aspects of genetic healthcare; (3) medical genetics; (4) human genetics; (5) ethics, law and sociology; (6) professional practice; and (7) education and research.

The need for appropriately trained genetic counsellors is now widely acknowledged. However, while programmes for education of genetic counsellors exist in a number of

countries, these do not conform to any specific international standards. Variance in the professional identity and training of genetic counsellors may be due to differing practice healthcare systems between countries but may also contribute to inconsistencies in standards of patient care. As genetic techniques, educational standards and professional standards have evolved, and with increasing mobility of genetic counsellors, it is of great importance to have some comparison of education and training between different countries. In addition, as many smaller countries do not have educational programmes for genetic counsellors, many will be trained in one country and work in another. Guidelines for uniform genetic counsellor education are needed to ensure the quality of professional practice, leading to equitable services for patients (Skirton et al. 2010a, b).

In this context, we conducted a systematic review to determine the components of educational programmes for genetic counsellors in peer-reviewed, published literature.

Methods

Conducting a systematic review enables the evidence on a particular topic to be gathered, analyzed and synthesized. Adherence to a rigorous set of guidelines is essential to ensure rigour and objectivity. We followed the process for systematic reviews developed by the Centre for Reviews and Dissemination (2009), which involves identification of relevant search terms, selection of studies based on explicit inclusion and exclusion criteria and quality assessment of papers.

The research question was ‘What are the components of professional education for genetic counsellors in the published literature?’ The objectives were to determine specific aspects of genetic counsellor training programmes including admission requirements, teaching methods, core competencies addressed and relationship between the programmes and professional registration or certification processes.

Search strategy

A search of five relevant electronic databases, Medline, CINAHL, Educational research complete, Web of Science and Scopus, AMED and PsychInfo, was conducted. Following an initial ad hoc search to determine the relevant search terms, we used the following terms within any part of the text: ‘genetic counselling’ OR ‘genetic counseling’ OR ‘genetic counsellor’ OR ‘genetic counsellor’ AND ‘education’ OR ‘training’ OR ‘Master program’ OR ‘curricula’ OR ‘curriculum’. The search focused on papers published in English between the 1st of January 2000 and 28th of February 2014. Although earlier programmes have existed for decades,

we were interested in the current education for genetic counsellors. However, some papers published within the time period of the review included information about older programmes.

Inclusion and exclusion criteria

Papers were eligible for inclusion if they (i) were based on research using qualitative, quantitative or mixed methods designs as well as descriptive reports; (ii) included data on components of existing training programs for genetic counsellors (admission requirements, teaching methods, core competencies, registration and certification process); and (iii) reported on existing training programs.

Papers were excluded if they (i) focused on career development of health professionals other than genetic counsellors, (ii) were focused on competencies without inclusion of content, and (iii) were related to theoretical components or curricula for genetic counsellor training programs (but do not discuss actual training programmes).

As a result of the initial search, we identified 481 potential papers for inclusion. After deleting duplicates, 406 papers were left for examination. Further to this process, a hand search of the indices of *Journal of Genetic Counseling* was made, resulting in identification of five additional papers. After reading the titles of all papers, a further 282 were excluded, leaving a total of 124 papers. The abstracts of these papers were read, and a further 86 were excluded on the grounds that they did not fit the inclusion criteria (see PRISMA diagram). The excluded papers focused on topics such as counslee-related issues, the genetic counselling process or disease specific genetic counselling issues, genetic counsellor attitudes and knowledge, topics related to genetic testing and comparison of interventions performed by genetic counsellors. Conference presentations, editorial comments and book chapters were also excluded in this stage. All 38 remaining papers were read in full text, and 27 papers were excluded because they did not include sufficient content on genetic counsellor education. As a result, 11 papers fitted the criteria for the review (see PRISMA diagram).

Quality assessment

As part of a systematic review process, each paper that is potentially for inclusion should be assessed for methodological quality. Papers that are not of a sufficiently high standard can then be excluded from the review of evidence. We used published scoring systems (Kmet et al. 2004; Joanna Briggs Institute 2014) to create an overall quality score for each paper. Two (MP and HS) of the authors independently rated each paper, and the scores were then discussed until consensus was reached.

The majority of the papers were reports for which there are few scoring systems; therefore, we used the Joanna Briggs Institute Notari scoring system [<http://joannabriggs.org/sumari.html>], which can be used for evaluating discussion or opinion papers (Joanna Briggs Institute 2014). It includes seven questions related to the veracity of the manuscript content and consistency with other published literature, and a score is allocated according to the response to each question. Although not ideal for our purposes, after slight adaptation, we used this tool to make a judgment on the quality of the reports. One of the papers was research-based, and for this, we used the scoring system devised by Kmet et al. (2004). This involves answering 14 relevant items related to issues such as study design, sample size and method of analysis by allocating a score of 2 (fully met), 1 (partially met) or 0 (not met) to each item. After scoring all papers, the total scores were then converted to percentages. The scores for all papers were above 70 % and therefore all were considered of sufficient methodological quality to be included in this review.

Data extraction

Several of the authors (CI, HS, CC, NT) were involved in data selection and extraction at every stage in the review. As the papers were so varied and the majority was not research-based, a meta-analysis was not possible. For each article, identifying information (such as objectives, research setting, study design, methods) was recorded, and data relevant to the research study were extracted (such as objectives, admission requirements for genetics education, and types of genetics education programme and characteristics of the programme).

Original data from the included studies were extracted and presented in Tables 1 and 2. A thematic analysis of the data was conducted and is presented in a narrative format.

Results

Table 1 summarizes the characteristics of the papers included in the study. All of the papers were published after 2005. Table 2 provides an overview of genetics education, as reported in the articles included in the study.

Of the 11 papers, three focused on genetic counsellors in Australia and one paper in each of the USA, France, the Philippines, Cuba, Taiwan, Israel, Saudi Arabia and South Africa, respectively. One study used a two-phase cross-sectional design (Bedard et al. 2007). The remaining 10 papers were descriptive reports. The

Table 1 Characteristics of included papers

Reference	Objective of the study	Study design/type of paper	Quality assessment % score based on assessment using tool by Kmet et al (2004)
Bedard et al. (2007), USA	To explore genetic counselling students' interest and training in research.	A two-phase cross-sectional (including directors and students).	85 %
Chien et al. (2013), Taiwan	To report on the development of genetic counselling services in Taiwan	Descriptive report	93 % Few data on GC programme
Cordier et al. (2013), France	To trace the development of the profession in France	Descriptive report	93 % Data sources not clear
Cruz (2013), Cuba	To report an overview of the history and current status of genetic services in Cuba	Descriptive report	79 % Not all figures referenced
Kromberg and Krause (2013), South Africa	To focus on the development of departmental activities at the department (division) of Human genetics in Johannesburg.	Descriptive report	100 %
Laurino and Padilla (2013), The Philippines	To explain how the Philippines implemented the Master of Science programme and how to overcome the challenges the programme faced to help other to build similar programmes in other low- and middle income countries	Descriptive report	93 %
McEwen et al. (2013), Australia	To provide a detailed description of genetic counsellor training and certification in Australia	Descriptive report	86 %
Qari et al. (2013), Saudi Arabia	To describe the development of a genetic counselling training programme and the factors that lead to its establishment.	Descriptive report	86 % Few data on GC programme
Sagi and Uhlmann (2013), Israel	To summarize the history and training of Master level genetic counsellors in Israel.	Descriptive report	86 % Sources of data unclear
Sahhar et al. (2013), Australia	To explain the development of a 2-year Master programme evolving from a 1-year course ant to discuss principal challenges of developing the Master programme.	Descriptive report	93 % Sources of data unclear
Sahhar et al. (2005), Australia	To document the training and certification system for genetic counsellor in Australia, to compare these to other international programmes and to describe Australian experience of genetic counselling education and history of the profession.	Descriptive report	86 %

themes extracted from the papers were the following: (1) admission requirements for the programme, (2) basic information of the programmes, (3) teaching methods of the programme, (4) expected competencies from graduates, and (5) registration and certification requirement for genetic counsellors (Table 2).

Table 3 includes the content of genetic education programmes reported in these papers. Although the papers did not include the entire content of the programmes, the majority of authors provided the basic components. Depending on the background of students, duration and the level of education, content of the

education programme varied in a wide range of topics. Generally, programmes encompassed both clinical and theoretical teaching; however, authors of only two papers were mentioned, including counselling practice (Sahhar et al. 2013; McEwen et al. 2013).

Admission requirements for the programme

Authors of most papers stated that students of the programme should have an undergraduate or bachelor degree in science or health science (Qari et al. 2013; Sagi and Uhlmann 2013; Sahhar et al. 2013; Cordier et al.

Table 2 An overview of genetics education programmes

Reference and country	Admission requirements	Basic information	Teaching methods	Expected competencies from GC	Registration or certification for GC
Bedard et al. (2007), USA	Bachelor's degree	Accredited genetic counselling training programmes.	Formal education Research activity	–	–
Chien et al. (2013), Taiwan	Various medical backgrounds; nurses, medical technicians, MDs, research assistants a high school teacher, a psychologist and a founder of a biogenetic company.	A master-level genetic counselling programme. Started in 2003, since then 80 graduates.	Coursework and laboratory experience.	–	Taiwan association of genetic counselors (TACG) certifies genetic counselors since 2009.
Cordier et al. (2013), France	Undergraduate or postgraduate science degree or already practicing health professionals (e.g. PhD scientist, nurses, midwives, chemist).	Master's degree in genetic counselling and predictive medicine. 2-year programme Available since 2004 –107 graduates since then.	Academic and clinical training. Laboratory practicum recommended for nurses and midwives.	Provides a high level of knowledge in both scientific and medical fields, dealing with psychological, social and ethical aspects of genetic counselling.	Registration by the French Association of Genetic Counsellors
Cruz (2013), Cuba	Two different Master level programmes for university graduates. One for physicians with other specialties (e.g. in family medicine, paediatrics or obstetrics), second programme was for professionals such as psychologists, nurses or social workers.	Master in genetic counselling. Available since 2000. 837 graduates from 11 intakes—18 months training.	Practical training in a primary health care and a research project.	–	Programme certified by Ministry of Higher Education. legalized and obligatory re-certification process 10 years post qualification.
Kromberg and Krause (2013), South Africa		Master-level course in genetic counselling. Available since late 1980's. 2 years full time training In 2008 there were 15 registered GCs (There is also informal ad hoc genetics training for various health professionals, particularly nurses since the early 1980s)	–	–	Registration of genetic counsellor with Health Profession Counsel of South Africa (HPCSA)
Laurino and Padilla (2013), The Philippines	Completion of undergraduate degrees at least at a baccalaureate level in fields such as nursing, biology, chemistry, psychology, or related disciplines. Scholarship for full-time MSGC- students.	Master of Science in genetic counselling programme—Available since 2011. Two student cohorts have been accepted to the programme.	Didactic coursework, clinical rotations (at prenatal, cancer, general paediatric, metabolic and in-patient clinics) and overseas exposure of genetic counselling programme in USA and Australia	MSGC students are expected to earn a 'pass' grade on a written comprehensive examination, submit a logbook documenting at least 40 genetic counselling cases, and complete a thesis research project.	–
McEwen et al. (2013), Australia	Non-medical health professionals including nurses.	Masters-level postgraduate qualification. For a minimum of 2 years full time equivalent. Available since 2008.	Clinical, research and theoretical teaching, reflective practice, and attending both counselling supervision and genetic supervision.	Reflective practice, counselling and interview skills and case management skills	Certification involved a two-part process. Part 1 is to be Associate Genetic Counselor, and Part 2 is to be awarded Board Certification. Certification by the Human Genetics Society of Australasia (HGSA)

Table 2 (continued)

Reference and country	Admission requirements	Basic information	Teaching methods	Expected competencies from GC	Registration or certification for GC
Qari et al. (2013), Saudi Arabia	1 To be a Saudi National or one of the Arab Gulf State Countries. 2 To have a bachelor degree in Applied Health Science (biology, chemistry, biochemistry) or nursing with a cumulative grade point average of at least 3.0. 3 To have an excellent knowledge of written and oral English. 4 To pass the pre-selection examination conducted by Training and Development.	A high diploma-level programme in genetic counselling. 2 years training and a 6-month clinical internship at the end of the programme. Available since 2005. Have graduated 5 GCs	Didactic course work is delivered via lectures, group discussions, student led seminars, tutorials, and role-plays. Extensive clinical rotations (a medical genetics clinical rotation, OB/GYN a clinical rotation, and a haemoglobinopathies) Laboratory practice (Biochemical Genetics, Cytogenetics and Molecular Genetics laboratory practicum.) Coursework, clinical work and thesis.	At the end of the internship period, the trainees are administered an oral and written comprehensive exam to assess their preparedness as a genetic counsellor.	Accredited by the Saudi Commission as a postgraduate course in Genetic Counselling.
Sagi and Uhlmann (2013), Israel	2-years of army service–3 years of university studies (a Bachelor of Science degree in Biology, Medical Sciences; or in Psychology) having very high grades in undergraduate studies or the humanities.	Master's Degree genetic counselling training in two universities. 2-year programme. Total of 51 graduates as GCs (6 students at a time) Available since 1997 and 2009. Master of genetic counselling programme 2 years training. Available since 2008	Self-directed learning approach: Role-plays and encouragement of self-reflection. Use of process records to document genetic counselling interviews, use of group process. Weekly tutorials. Journal club presentations, case presentations and facilitated discussions, videotaped simulated patient session. Undertaking a clinical placement overseas.	–	Registration by the Israeli Corporation Authority at the Ministry of Justice as 'The Israeli Association of Genetic Counselors' since 2008. Certification by the certification board Human Genetics Society of Australasia (HGSA)
Sahhar et al. (2005), Australia	Completion of undergraduate studies in science or the humanities.	4 different programmes; Graduate diploma in/of genetic counselling (1 year full time or 2 years part time) Master of Health science (1 year part time/full time or 2 years part time) Master in/of genetic counselling (6 months full time, 1 year full time, or 2 years part time) Master with honours in genetic counselling (research project 6 months full time or 1 year part time) Available since 1995.	Problem-based learning tutorials, clinic observations, lectures, seminars, coursework, laboratory practice, research, clinical training and distance education, depending on programme	Proposed competencies, professional and ethical practice interpersonal, counselling and interviewing skills, communication skills critical thinking and analysis. To be certified the GC must demonstrate adequate knowledge in genetics, counselling theory and practical application of counselling skills	Board of Censors in genetic counselling defines a minimum standard of academic and practical training for GCs as well as administering a certification process. The board is affiliated with Human Genetics Society of Australasia (HGSA).

2013; Laurino and Padilla 2013) or nursing (Qari et al. 2013; Laurino and Padilla 2013; Cruz 2013; Cordier et al. 2013); other authors mentioned graduates in psychology (Sagi and Uhlmann 2013; Laurino and Padilla 2013; Cruz 2013) or humanities (Sahhar et al. 2013) as suitable candidates. In Cuba, there were two different programmes where the first of the programmes was for physicians with specialties other than genetics (such as family medicine, paediatrics or obstetrics) (Cruz 2013), and the second was designed for other professionals such as psychologists, nurses or social workers to enable them to become genetic counsellors. In Taiwan, students with various medical backgrounds such as nurses, technicians, doctors and psychologist could participate in the programme (Chien et al. 2013). In France practicing health professionals were eligible (Cordier et al. 2013), while in Australia, the programme was mostly targeted at non-medical health professionals (McEwen et al. 2013). Other pre-requisites stated were, for example, excellent knowledge of written and oral English (Qari et al. 2013), 2-year military service and very high undergraduate grades (Sagi and Uhlmann 2013) or specific citizenship (Qari et al. 2013).

Basic information of the programmes

Authors of all papers, except one (Sahhar et al. 2005), described 2-year (full-time) Master programmes in Genetic Counselling. The paper by Sahhar (2005) reports on the 1 year graduate diploma programme that was offered in Australia at that time. Because that programme was superseded in 2008 by the 2 year Master course (Sahhar et al. 2013), we include the paper in the tables for completeness but will not include those results in the narrative text. The oldest Master programme described, from which 51 genetic counsellors had graduated, started in Israel in 1997 (Sagi and Uhlmann 2013). However, 837 genetic counsellors had graduated in Cuba since 2000 (Cruz 2013). The most recently developed programme, available since 2011, was in the Philippines (Laurino and Padilla 2013).

Teaching methods of the programme

All programmes include didactic coursework or formal education. The didactic coursework was delivered via lectures, group discussions and student-led seminars. Other important teaching tools were role-play, encouragement of self-reflection, videotaping and problem-based learning (Sahhar et al. 2013). In addition, many programmes include clinical training in relevant healthcare clinics, for example prenatal, general paediatrics and cancer (Qari et al. 2013; McEwen et al. 2013;

Laurino and Padilla 2013; Cordier et al. 2013; Sagi and Uhlmann 2013; Sahhar et al. 2013) or in primary health care (Cruz 2013). Some programmes include a research project or a thesis (Qari et al. 2013; Bedard et al. 2007; Sahhar et al. 2013; Sagi and Uhlmann 2013; McEwen et al. 2013; Cordier et al. 2013; Laurino and Padilla 2013) and some included laboratory work (Qari et al. 2013;; Cordier et al. 2013; Chien et al. 2013).

Content of the programmes

The information on the course content was limited in some papers. However, where course content was included, some common areas could be identified.

Theoretical subjects

Genetic Genetics was included in a range of formats. Basic and molecular genetics were mentioned when describing the content of the programme in Saudi Arabia (Qari et al. 2013) and in Australia (Sahhar et al. 2013). Human genetics and human population genetics courses were also included in the Saudi Arabian curriculum (Qari et al. 2013). Other authors mentioned clinical or medical genetics courses (Qari et al. 2013; Sagi and Uhlmann 2013; McEwen et al. 2013; Chien et al. 2013) as part of the programme. Other subjects mentioned were metabolic diseases molecular cytology, embryology, fetal ultrasound (Sagi and Uhlmann 2013) and pathology (Cordier et al. 2013).

Counselling Authors of six of the papers stated that courses in counselling skills (Qari et al. 2013; Sahhar et al. 2013; McEwen et al. 2013; Cordier et al. 2013; Chien et al. 2013) or health communication skills (Sahhar et al. 2013) were part of the programme.

Ethics and psychological issues The programme in Saudi Arabia included courses in cancer genetic counselling, psychological aspects of genetic counselling and genetic counselling and Islam. In Israel, the programme included courses on decision making and ethics in modern genetics (Sagi and Uhlmann 2013).

Research methodology and thesis

Some of the programmes included research design and methodology courses (Bedard et al. 2007; Sahhar et al. 2013; Sagi and Uhlmann 2013; Cordier et al. 2013) as well as statistics or biostatistics (Bedard et al. 2007; Sagi and Uhlmann 2013; Chien et al. 2013). In eight of the papers, it was stated that a research project (Kmet et al. 2004; Kromberg and Krause 2013; Cruz 2013) or a formal thesis (Qari et al. 2013;

Table 3 Content of genetic education programmes

Reference	Content of the programme
Bedard et al. (2007)	A formal thesis requirement (62 %), research design courses (58 %), biostatistics courses (42 %) and independent study projects (35 %).
Chien et al. (2013)	Course work includes genetic counselling related courses medical genetics and statistics.
Cordier et al. (2013)	40 weeks of formal instruction and 28 weeks of clinical rotations. 11 compulsory and 5 elective courses and clinical rotations. Methodological course work Genetic counselling and pathology Elective coursework
Cruz (2013)	Four curricula areas. Practical training.
Kromberg and Krause (2013)	2 years full time formal teaching and clinical training, research project and 2-year internship.
Laurino and Padilla (2013)	Specific topics (e.g. cancer genetics, neurogenetics) that are included in the established training programme in developed countries included as modules in the Genetics course.
McEwen et al. (2013)	Part 1 involved completion of a checklist of core knowledge in aspects of genetics and counselling obtained by enrolling in existing university programmes and/or through additional training such as professional development courses within the clinical genetics unit where the trainee genetic counsellor was employed. Part 2 involved completion of a prescribed number of written cases and annual education reports while working under supervision as a trainee genetic counsellor
Qari et al. (2003)	Introduction to human genetics Human population genetics The genetic basis of inherited disease Clinical genetics review course, topics in genetic counselling I Topics in genetic counselling II, psychosocial aspects of Genetic counselling, cancer genetic counselling, and genetic counselling and Islam
Sagi and Uhlmann (2013)	Year 1: Basic clinical genetics, molecular genetics, gene expression, molecular cytogenetic, metabolic diseases, genetic screening, seminar in medical genetics, genetic lab technologies, observational clinical training Year 2: Advanced clinical genetics, molecular genetics, embryology, fetal ultrasound, statistics for GCs, medical psychology, seminar in medical genetics, decision-making course, seminar on research in GC, workshop (role-play) in GC, ethics in modern genetics and clinical training. Note: graduates from in Psychology have to take a year of supplementary studies in Biology.
Sahhar et al. (2013)	1st year: Three genetics subjects, one counselling skills and two health communication skills subjects, one research design and methodology subject + observation in genetics clinics and placement in community setting 2nd year: Completion of minor thesis on a supervised topic, clinical placements and attending a weekly counselling practice tutorial.
Sahhar et al. (2005)	Genetics, legal, ethical and psychosocial issues that face families as more tests available.

Bedard et al. 2007; Sahhar et al. 2013; Laurino and Padilla 2013; Sagi and Uhlmann 2013) was a requirement.

Clinical practice and rotation

Of the papers in which content of the programmes was included, seven programmes had some kind of clinical practice or

observational clinical training included in the curricula (Sahhar et al. 2013; Sagi and Uhlmann 2013; McEwen et al. 2013; Laurino and Padilla 2013; Kromberg and Krause 2013; Cruz 2013; Cordier et al. 2013). The duration and form of clinical practice differed between the programmes. In France, for example, there were clinical rotations of 28 weeks (Cordier et al. 2013), whereas in Cuba, students had 428 h of

training (Cruz 2013). In Australia, practice included working as a trainee genetic counsellor under supervision (McEwen et al. 2013) and observation at genetics clinics, as well as placements in a community setting (Sahhar et al. 2013).

Expected competences of graduates

At the end of every programme, students undertook oral and written examinations to test their preparedness as a genetic counsellor. Students were expected to have knowledge of both genetics and scientific and medical fields, as well as in social, psychological and ethical aspects of genetic counselling. In addition, required competences included counselling theories (Sahhar et al. 2005), communication skills, interviewing and counselling skills and critical thinking and analysis (McEwen et al. 2013; Accreditation Council for Genetic Counseling ACGC. Standards of accreditation for graduate programs in genetic counseling 2013). In the Philippines, the students were expected to document more than 40 counselling cases (Laurino and Padilla 2013).

Registration and certification requirement for genetic counsellors

There were registration or certification processes for genetic counsellors reported in Australia (McEwen et al. 2013), Israel (Sagi and Uhlmann 2013), France (Cordier et al. 2013), Taiwan (Chien et al. 2013) and South Africa (Kromberg and Krause 2013). In Australia, there is a rigorous certification process under the Board of Censors for Genetic Counselling assigned by the Human Genetics Society of Australasia (HGSA) (McEwen et al. 2013). In addition, the programmes in Cuba (Cruz 2013) and Saudi Arabia (Qari et al. 2013) have been accredited by the education system in each country.

Discussion

Core competences for the genetic counselling profession have been established (Skirton et al. 2010b, 2013a; Yashar and Peterson 2013; Accreditation Council for Genetic Counseling ACGC. Standards of accreditation for graduate programs in genetic counseling 2013). In addition, educational standards and competences of genetic counsellors have been agreed upon in Europe (Skirton et al. 2010a) as well as in the USA (Accreditation Council for Genetic Counseling ACGC. Standards of accreditation for graduate programs in

genetic counseling 2013). In the studies included in this review, all current genetic counselling programmes were 2-year Master programmes. This is in accordance with the ACGC standards for accreditation of graduate programmes in genetic counselling (Accreditation Council for Genetic Counseling ACGC. Standards of accreditation for graduate programs in genetic counseling 2013), which states that all graduate programmes in genetic counselling are required to provide training over a minimum of 21 months or two academic years. Two-year Master programmes also comply with the European standards, as the professional and educational standards for genetic counsellors in Europe state that a genetic counsellor is a health professional who has undertaken a period of education and training at Master level, and this is a requirement for registration by the EBMG (Skirton et al. 2013a; European Board of Medical Genetics EBMG 2014a).

Our findings indicate that the programmes correlated well with both the European core competencies that state counselling skills, psychological issues, medical genetics, human genetics and ethics/law/sociology to be included in the training programme (European Board of Medical Genetics EBMG 2014b) and the ACGC standards, which show similar instructional content in their curricula, e.g. human and medical genetics, science related to medical genetics, psychosocial content including counselling and social, ethical and legal issues in genetics (Accreditation Council for Genetic Counseling ACGC. Standards of accreditation for graduate programs in genetic counseling 2013). In addition to these theoretical courses, competencies in research methods and education are part of the curricula of genetic counselling Master programmes (Accreditation Council for Genetic Counseling ACGC. Standards of accreditation for graduate programs in genetic counseling 2013; European Board of Medical Genetics EBMG 2014a), and these were included in the majority of programmes assessed in this review.

Although many programmes combined formal education and clinical training, the duration and components of clinical training are not clear in majority of the papers included in the review. Authors of seven papers described clinical practice or observation, but the format and duration of clinical practice differed between the programmes. The proposed European curricula (Skirton et al. 2010a, 2013a; European Board of Medical Genetics EBMG 2014a, b) states that Master programmes for genetic counsellors should include practical training for at least 50 % of the training hours, and

that at least half of that practical training should be clinical practice in a genetic centre (Skirton et al. 2013a). The ACGC standards (Accreditation Council for Genetic Counseling ACGC. Standards of accreditation for graduate programs in genetic counseling 2013) indicate that the clinical case experience must illustrate the student has had a diverse training to prepare him or her to provide effective genetic counselling within a variety of practice settings, so those programmes that do not include substantial clinical training could be judged to be unfit for purpose. For this reason, more collaboration to produce agreed international standards is needed. The Transnational Alliance of Genetic Counsellors (Transnational Alliance of Genetic Counsellors (TAGC) 2014) was established in 2008 as an informal organization for Genetic Counselling Master programme course directors. The aim of TAGC is to foster communication and collaboration amongst providers of genetic counselling programmes. Although the TAGC has no legal standing, members would be important stakeholders in such initiatives, e.g. by gathering information on and comparing different programmes, and from that, create an international consensus regarding learning outcomes and registration systems. This knowledge could be shared internationally through international conferences, research collaborations and by facilitating exchange of qualified practitioners, faculty and students between countries. However, to ensure compliance, support by legal entities in each region or country would be desirable. In this review, there was little evidence discovered related to learning outcomes of courses, and this is another area where there is potential for international consensus.

One of the key issues that arise from this review is the need for Master level education to be available for the training of genetic counsellors. In Europe, there are approved courses in only five countries (European Board of Medical Genetics EBMG 2014a), meaning that unless prospective counsellors are able to fund their studies outside their home country and are able to study in a second language, there is no opportunity for them to achieve the required standard of education. This obviously reflects upon the level of care they can offer. It is financially difficult for institutions to support such courses in countries with low populations; therefore, individual courses in each country may not be feasible. However, as culture, ethnicity and religious faith all have an influence on the impact of the genetic condition in a family and on the options and opportunities available to families, it is important that students are trained in the context of their own culture. Solutions to this problem need to be urgently sought at the European level, and one option would be to develop European

courses for the theoretical components, with local opportunities for practical training, or to organise courses across several countries with a common language or similar cultural mores. E-learning is an option that could be utilised to enable broad accessibility of courses.

Strengths and limitations

This was a comprehensive review of all published material on educational programmes for genetic counsellors. The review of the papers identified in the search and the quality appraisal was conducted by two experienced researchers, enhancing the rigor of the work. The number and range of countries represented is also a strength; however, it should be noted that many of the papers were descriptive reports rather than research-based papers. Moreover, this review does not include the programmes in genetic counselling in some countries such as USA or UK even though they have accredited and standard curriculum, since these programmes in genetic counselling have not been reported or published in peer-reviewed journals. It would be interesting to do some further research, using different methodology, to investigate and evaluate the curricula of all existing programmes in genetic counselling. We chose to undertake this review using only papers and reports that had been subjected to peer-review, to enhance the rigour of the findings. However, it would be possible to undertake the study using a search of grey literature (such as programme websites) or by collecting data directly from course directors or national professional organizations.

Conclusions

According to the results of this review of evidence published in the peer-reviewed literature, in general, the theoretical components of genetic counsellor programmes conform to the recommendations and requirements of professional bodies. However, it is concerning that the clinical preparation of genetic counsellors in real-life professional practice settings seems to be less well addressed. As genetic counsellors may move directly from their training programme into practice, they may not have sufficient clinical experience to offer safe care for patients. It is important that genetic counsellor programmes include not only academic courses but also practical preparation for professional work. Further work to introduce international standards of training will benefit the profession and ultimately, the patients.

Compliance with ethical standards

Conflicts of interest This work has been performed by the authors without external funding. The authors declare no conflict of financial or non-financial interest. This study did not involve sensitive personal information, animal research, biological samples, or manipulation of subjects physically or psychologically. It was therefore exempt from ethical approval.

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